Compressed Air Magazine

DECEMBER 1945

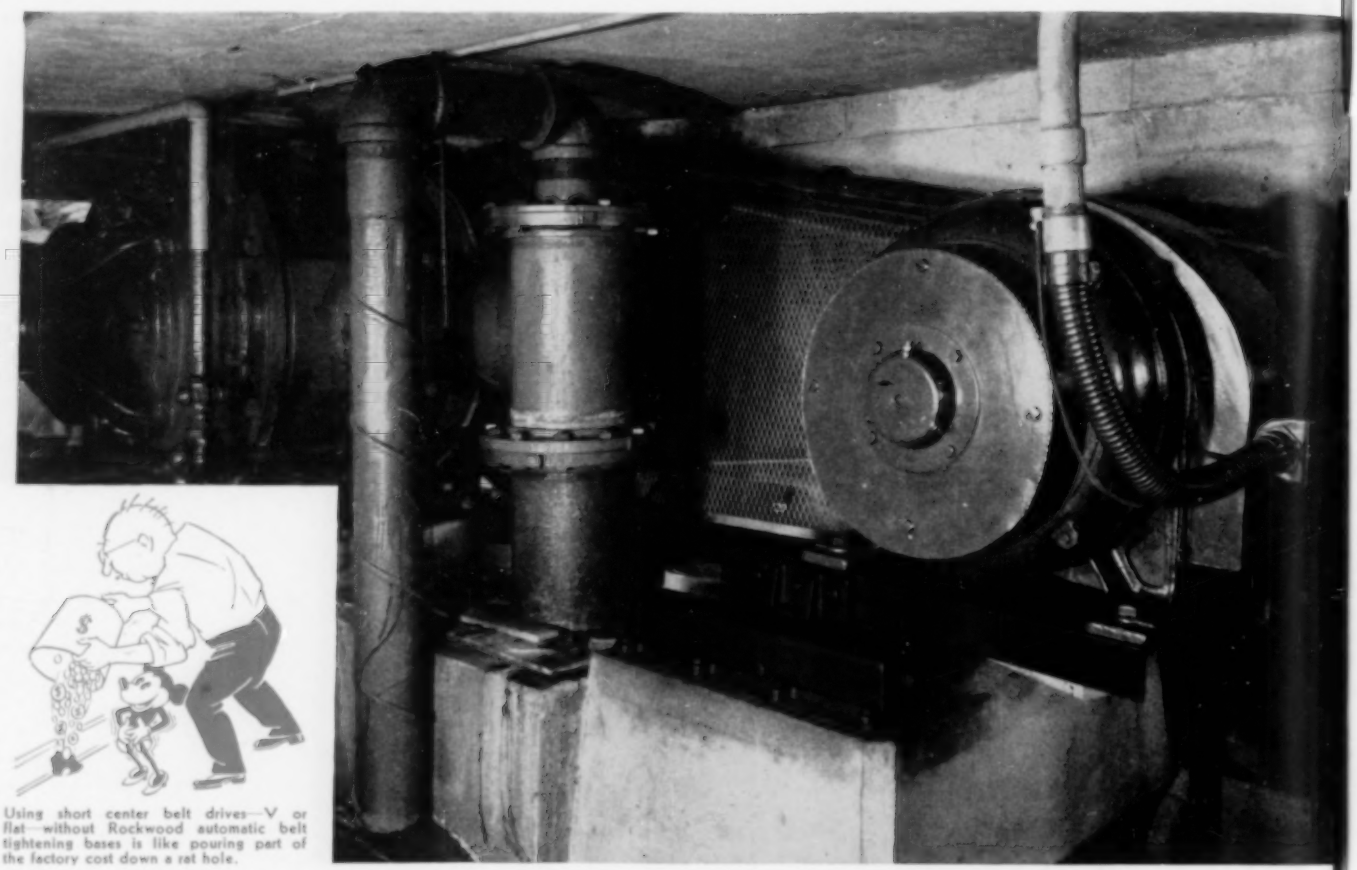
GUN THAT BROKE JAP AIR POWER

The gunsight that makes it so deadly depends on air-spun gyro

(See Page 328)

VOLUME 50 • NUMBER 12 NEW YORK • LONDON

RUN YOUR MACHINES AT UNIFORM MAXIMUM SPEEDS regardless of load change



Using short center belt drives—V or flat—without Rockwood automatic belt tightening bases is like pouring part of the factory cost down a rat hole.

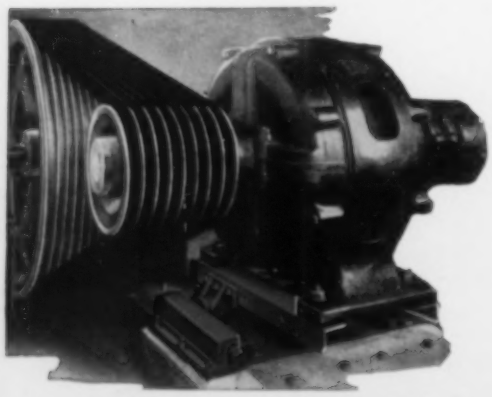
ALL COMPRESSOR BELT DRIVES SHOULD HAVE THE BELT TENSION CONTROLLED AUTOMATICALLY

Compressor engineers know that without tension control, belts slip at peak loads, power is lost, the compressor momentarily loses speed, its capacity is correspondingly reduced—and the belts wear out much faster due to friction and heat of slippage.

When a belt tension is controlled with a Rockwood belt tightening motor base the tension **automatically** matches the load at every part of the stroke, increasing when the peak is reached and falling off again when the intake begins. **This means the compressor is kept to maximum speed continuously, the compressor capacity is dependable and consistant, pressures are built up in less time, drive trouble and belt breakdowns are eliminated, belt replacement costs cut in half, while overall power costs are reduced.** So fundamental is this that the compressor manufacturer who provides Rockwood motor bases as standard equipment will have the advantage over competitors who provide wasteful, inefficient drives with no provision for automatic belt tension control.

The hand writing is on the wall. What compressor buyer would knowlingly purchase a compressor with its capacity unnecessarily restricted, that has to run longer periods to keep up its pressure, where the belts slip and wear out almost twice as fast—plus using extra power.

Automatic belt tension control was originated and pioneered by Rockwood. Rockwood pivoted bases can be had from stock for all motors up to 60-75 h.p.—in semi stock to 250 h.p. Still larger sizes made to order. AVAILABLE TO COMPRESSOR MANUFACTURERS TO MEET ANY DESIRED SCHEDULE.



All multiple V belt drives on compressors have belt slip—sometimes over 10%—if the belts are not kept tight automatically with Rockwood motor bases.

ROCKWOOD

INDIANAPOLIS, INDIANA

More than a "Separator"

PROTECTOMOTOR PIPE LINE FILTER DELIVERS *Clean* AS WELL AS *Dry* AIR

Rust, Pipe Scale, Dirt and Dust removed in addition to Water and Oil

Repeat orders from hundreds of leading American concerns prove that Protectomotor Pipe Line Filters save money, speed production. Easy and quick to install, Protectomotors have often saved their entire cost in a single month.

Find out how in your operation Protectomotors will increase output, help win the war.

WRITE FOR CATALOG

DOLLINGER CORPORATION

(Formerly STAYNEW FILTER CORP.)
7 CENTRE PK. ROCHESTER 3, N. Y.

Air Filter Headquarters

FILTERS FOR PIPE LINE, ENGINE INTAKE AND BUILDING VENTILATION

Temperature Changes Mean Trouble in Unprotected Air Lines

Moisture in compressed air is condensed as the air passes through cold sections of pipe. Unless removed, this water washes out lubrication from air-powered tools, freezes upon expansion in these tools, and causes loss of power or stoppage due to clogging of ports; causes delays and waste at other points of compressed air usage. Staynew Pipe Line Filters (Protectomotors), installed as near point of use as possible, remove water and oil, preventing these troubles.

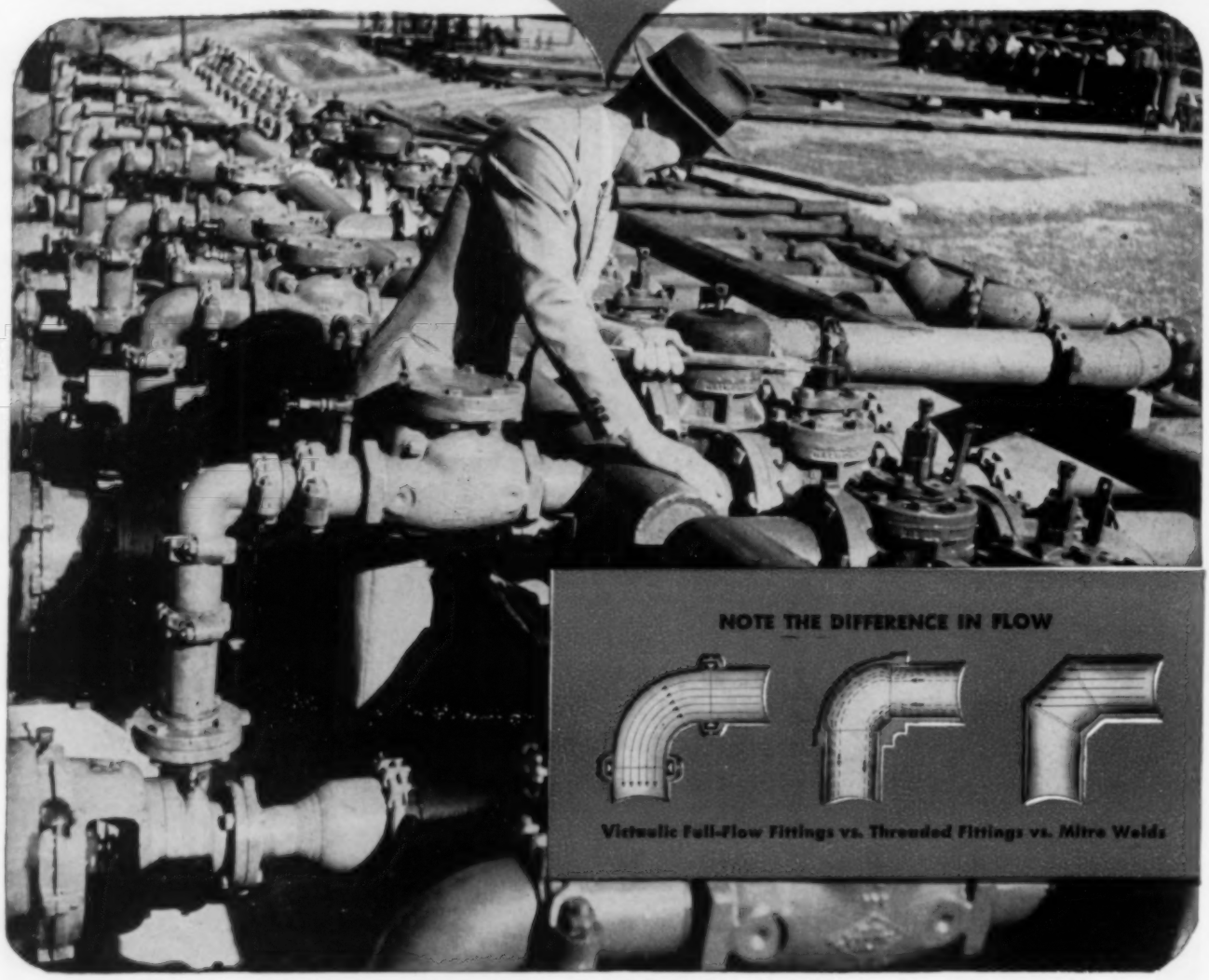
Model CPH

Double Action ★ Exclusive Construction

Air or gas strikes deflector (2), and is impinged against sides of housing (1). Oil, water, and heavy dirt particles drop to bottom and are drawn off thru drain (5). Fine dirt particles are removed from air or gas by positive action of the dry-type filtering medium which covers the patented Radial Fin Insert (4). Louvred housing (3) evenly distributes air or gas over surface of insert.

STAYNEW PROTECTOMOTOR FILTERS

Maximum Control Efficiency with VICTAULIC!



Victaulic Full-Flow Fittings and Couplings prove their greater economy at the Standard Terminal and Bulk Plant, Friendship, N. C.—Standard Oil Company (N.J.) photo.

WAR BONDS
A PIPE LINE FROM YOU TO HIM

Proved engineering design gives you increased pipeline delivery... lower pumping costs... with Victaulic Pipe Fittings.

Victaulics have long radii... wide, smooth sweeps! They have smooth, true-circular walls with *no internal projections*... no pockets! Victaulic Fittings feature an easy-fitting longitudinal tolerance plus an angular tolerance at each joint... and can be swiveled and set at any angle through 360°... acting in effect as swing joints. They can be independently removed from the line without disturbing the balance of the system.

What can these Victaulic Fitting features mean to you?

- REDUCED FRICTIONAL LOSSES
- MORE EFFICIENT FLOW
- INCREASED PIPELINE DELIVERY
- LOWER PUMPING COSTS

Write on your company letterhead for your free copy of the Victaulic Catalog and Engineering Manual. VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. Other Victaulic Offices: Victaulic, Inc., 727 West 7th Street, Los Angeles 14, California; Victaulic Company of Canada, Ltd., 200 Bay Street, Toronto.

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

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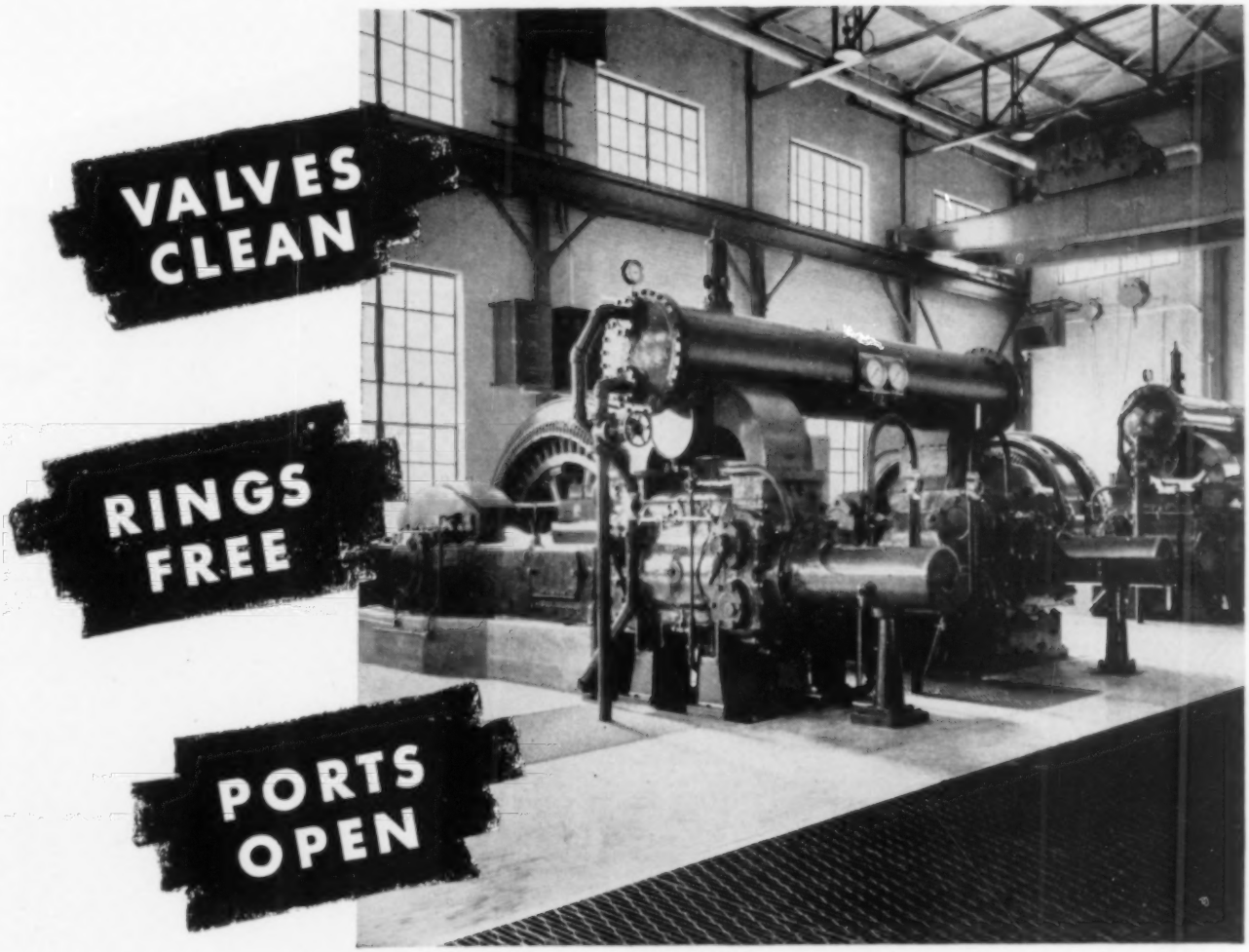
OIL MINING MARINE MUNICIPAL INDUSTRIAL



With compressor oils that don't form hard carbon deposits

GET these important benefits . . . assure fewer repairs and replacements, longer and more trouble-free service between overhauls, better performance at lower cost . . . by lubricating your air compressor with *Texaco Alcaid, Algol or Ursa Oils.*

Texaco Alcaid, Algol and Ursa Oils are products born of many years of intensive research by The Texas Company in the field of air compressor lubrication. They are made from carefully selected crudes. The lubricating fractions are processed by modern Texaco methods in one of the world's largest refineries under the constant supervision of trained Texaco technicians. This is your assurance of uniformly high quality no matter where you buy them.

Texaco Products and Lubrication Engineering Service are available through more than 2300 Texaco distributing plants in the 48 States. Contact the nearest one, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

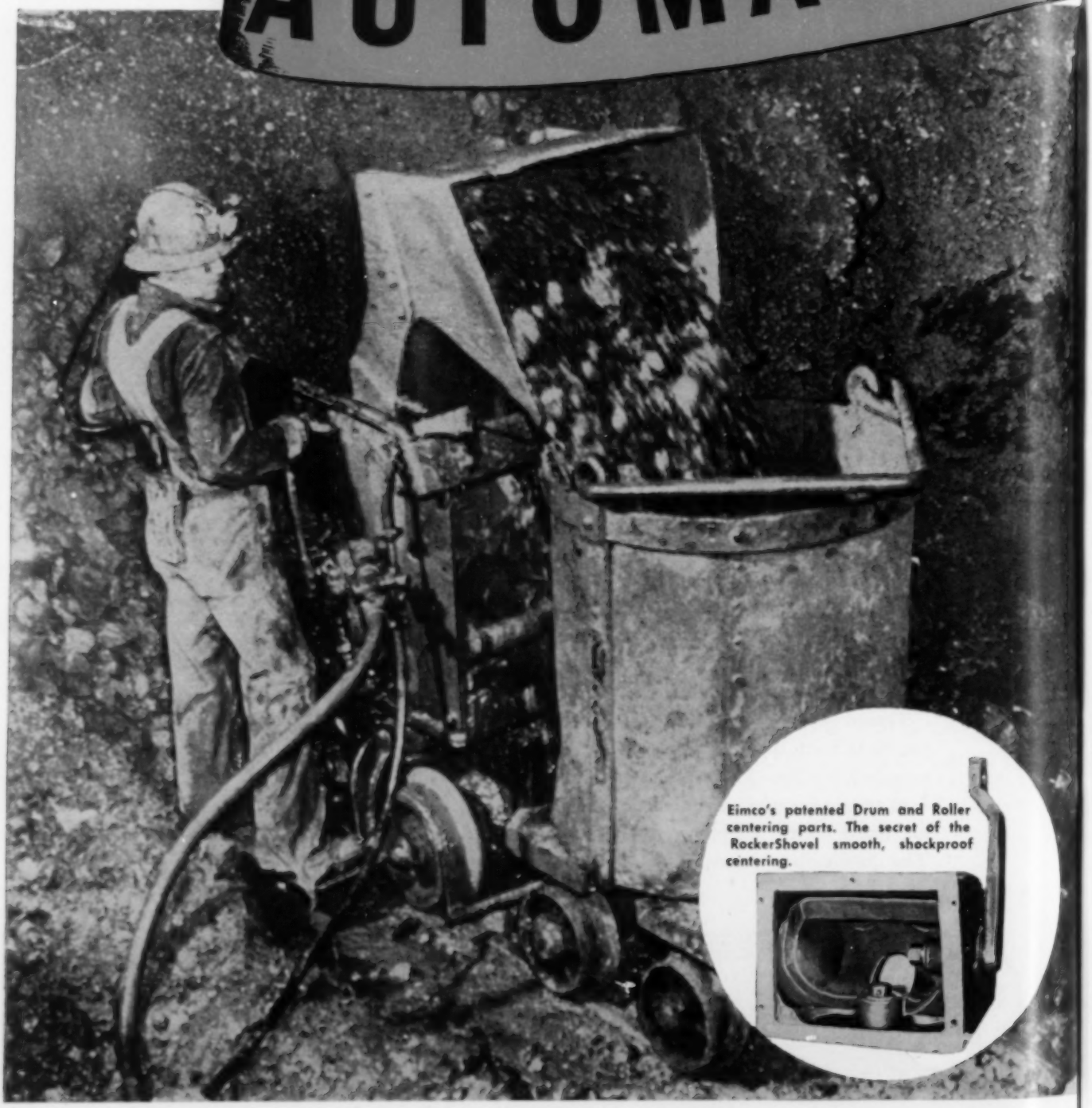
TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

fully enclosed

AUTOMATIC



Eimco's patented Drum and Roller centering parts. The secret of the RockerShovel smooth, shockproof centering.

CENTERING

Another RockerShovel Patented Feature

Eimco's Model 12B and 21 RockerShovels employ "Automatic Centering"—a fully enclosed, simple acting, patented device which gives positive positioning of the bucket for dumping into the car.

Thru "Automatic Centering" the RockerShovel operator unconsciously develops a smooth, easy rhythm in loading which is impossible when he must center the machine thru his own efforts.

"Automatic Centering" was originated and developed by Eimco engineers to provide a fast, dependable loading action with a maximum of safety. Thousands of RockerShovels, operating every day for many years without a minute of centering trouble, prove that Eimco's "Automatic Centering" is 100% efficient and trouble-free, and a true companion to the famous RockerShovel loading action which it serves. This is what happens:

1. In side digging position, the RockerShovel bucket rises in a vertical plane, not laterally, until it works its way through the muck pile before it starts to center. No dragging of the bucket sidewise thru the muck.
2. After leaving the muck pile, the bucket of the RockerShovel centers rapidly and smoothly during its upward motion. No shock or overswing in the positive action of Eimco's centering device.
3. The centered bucket travels the long unfinished portion of the arc, gaining momentum and discharge distance. The centered load is accelerated during the last portion of the arc to provide clean discharge of the bucket and to place muck all the way back in long cars.

There is no substitute for a RockerShovel—more tonnage at lower costs, faster development work underground and dependable 24-hour operation. All these success elements are assured when you use a RockerShovel. Write for information.

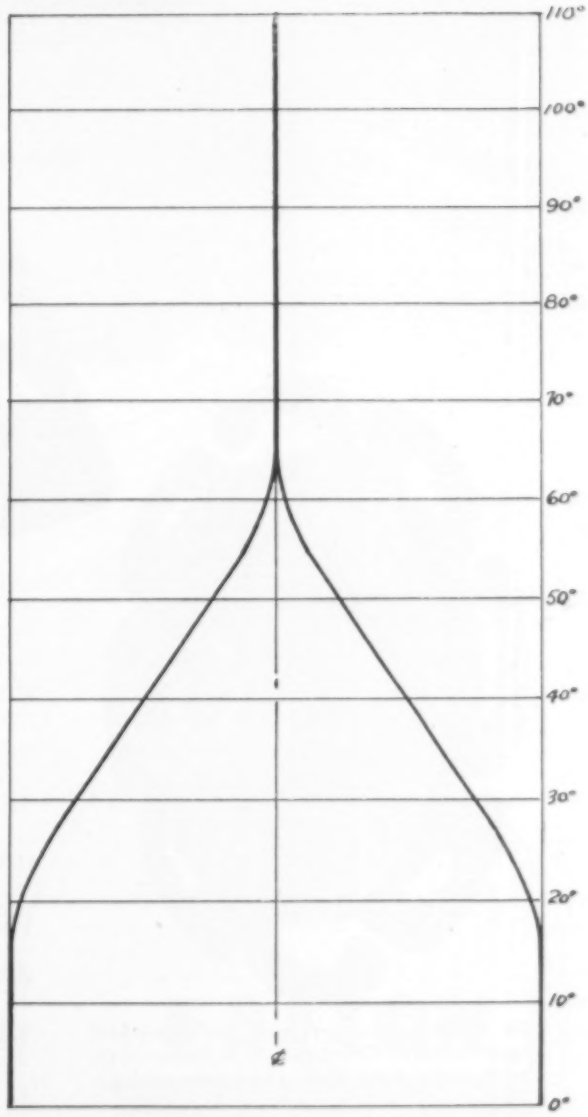


Diagram of path of bucket lip on Eimco RockerShovel from rest 0° thru loading arc to dumping point 110°. Note smooth, even path of centering which can be accomplished only by Eimco's PATENTED fully-enclosed "Automatic Centering."

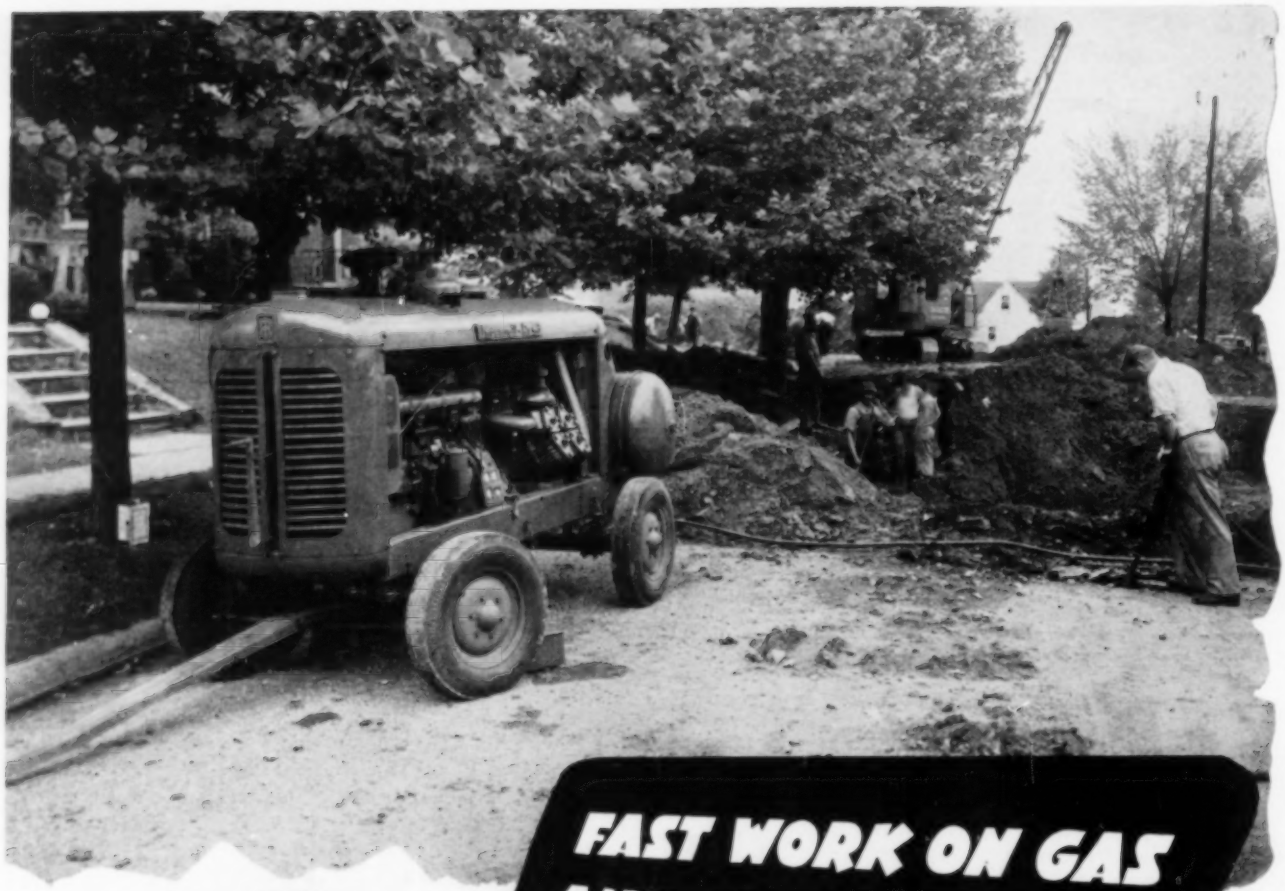
A-105

EIMCO

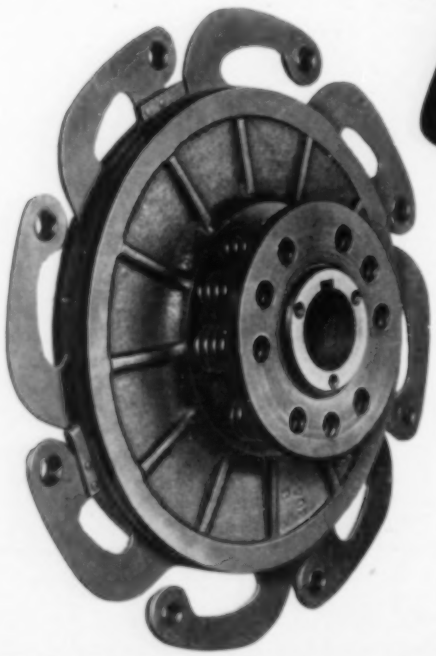
THE EIMCO CORPORATION

The World's Largest Manufacturer of Underground Rock Loading Machines

Executive Offices and Factories: Salt Lake City 8, Utah
Branches: New York, Chicago, El Paso, Sacramento, St. Louis



FAST WORK ON GAS AND WATER MAIN REPAIRS.....



I-R *Mobil-Air* Compressors are equipped with *Flex-Disc* Clutches — U. S. Patent Nos. 2,177,362 and 2,259,461 and others pending.

depends on reliable tools. *I-R* Paving Breakers and *Mobil-Air* Compressors equipped with *Flex-Disc* Clutches will keep the air on and clean up the situation in shortest possible time. *Flex-Disc* Clutches are designed for continuous duty with no attention but infrequent lubrication.

C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin

WHY shuttle several costly units from platform to platform when you can

move the whole platform!

One tractor with one driver can keep several platform trailers busy.

Load and unload by running your electric trucks right onto the trailer. Tractor is released for other work while the trailer is being loaded.

Pick up the ready trailer and move it to any part of your plant—from building to building, or from loading to shipping platform.

If you have an extensive intra-plant materials handling problem you can reduce costs and increase efficiency with EASTON off-the-highway platform trailers. The trailer illustrated is the EASTON Model TP-15 built to your standard platform height with 180 sq. ft. of loading area, and a capacity of 30,000 lbs. Other sizes and capacities are available. Write for information: Engineering Counsel, Easton Car & Construction Co., Easton, Pa.

EASTON

TRAILERS · TRUCK BODIES
CARS · ELECTRIC TRUCKS

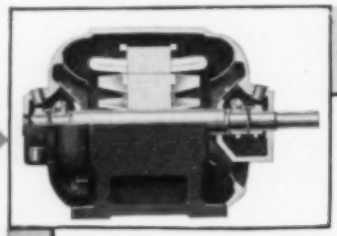
ENGINEERED

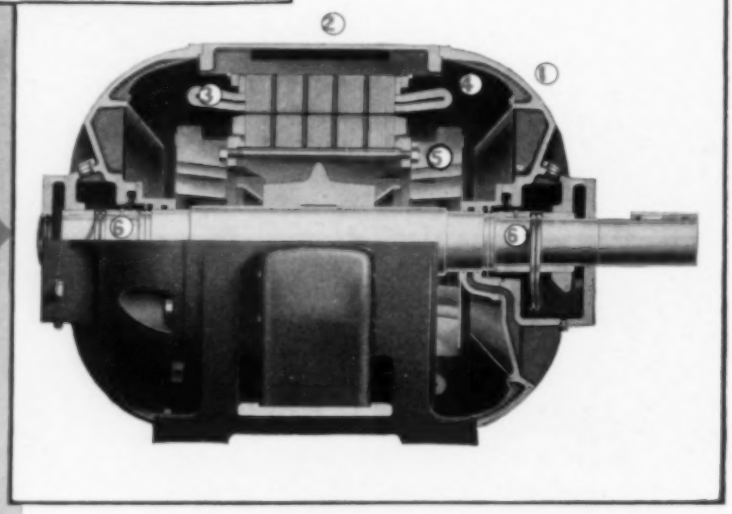
A-1010

SAME STRONG POINTS OF CONSTRUCTION

from 1 hp

to 2000 hp





Now all your drives — large and small — can have standard G-E Tri-Clad induction motors with the famous protective features that guard against PHYSICAL DAMAGE, ELECTRICAL BREAKDOWN, OPERATING WEAR AND TEAR.

Tri-Clad, in its wide range of types and sizes (recently increased to 2000 hp), is G.E.'s most widely used (integral-hp) motor. For complete details on ratings, characteristics, and dimensions, write for Bulletin GEA-3580. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

HERE'S TODAY'S WIDER RANGE OF STANDARD SIZES	
Tri-Clad Type K (Low starting current, normal starting torque)	1 hp to 2000 hp at 1800 rpm
Tri-Clad Type KG (High starting torque, low starting current)	5 hp to 200 hp at 1800 rpm
Tri-Clad Type KR (High starting torque, high slip)	Available to 100 hp in speeds required for high-slip flywheel drive (punch press, etc.)

1. Cast-iron frame and rigid, cast-iron end shields protect the motor from external blows and accidental abuse.
2. Completely enclosed upper portion of frame guards against entry of falling objects and dripping liquids; keeps chips and the like from vital motor parts.
3. Windings of Formex* wire—one of the toughest magnet wires yet developed—resist heat aging, heat shock, and abrasion.
4. End windings are coated with Glyptal* varnish, providing a tough, hard finish that withstands moisture, oil, and abrasion.
5. Low-velocity, double-end ventilating system keeps the motor running cool and prolongs insulation life. One-piece, cast-aluminum rotor (used on all but the largest sizes), with integrally cast fans, is practically indestructible.
6. Bearings have extra capacity to take heavy shaft loadings from any direction. Lubrication is convenient, its effectiveness well proved.

*Trade-mark reg. U. S. Pat. Off.

TRI CLAD MOTORS

Buy all the BONDS you can — *and keep all you buy*

750-296-8030

GENERAL ELECTRIC

WALWORTH LUBRICATED PLUG VALVES

offer these advantages

. . . Direct port opening

. . . Quarter turn opens or closes valve

. . . Dead tight shut-off

. . . Freedom from attack by fluids being handled

. . . Pressure sealed

. . . Made in a complete line. Sizes from ½" to 24" for pressures from 125 to 5,000 psi., and for vacuum requirements

THESE are just a few of the reasons why Walworth Lubricated Plug Valves give "top" performance on many *difficult* services.

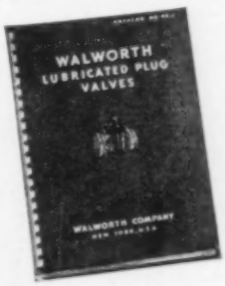
All Walworth Lubricated Plug Valves employ special insoluble lubricants which protect the plug and body against contact with the line fluid, thus combatting erosion and corrosion.

The lapped surfaces of the valve are "pressure sealed" when the valve is in either the open or closed position. By turning the lubricant screw, lubricant is forced under high pressure through a grooving system that completely encircles the parts as well as the top and bottom of the plug.

The lubricant seals the valve against leakage, and reduces friction between plug and body. This permits easy, quick, full-opening, or tight shut-off with only a quarter turn of the plug.

Fig. 1700 (illustrated) is a Steeliron valve, wrench operated, designed for a working pressure of 200 pounds WOG (water, oil, or gas). Valves are available in either screwed or flange types. Screwed type have API line pipe thread lengths. Flanged type are faced and drilled to American Standard for 125-pound cast iron flanges unless otherwise specified.

For further information about Fig. 1700, as well as the complete line of Walworth Lubricated Plug Valves write for Catalog No. 44L.



SEND FOR THIS FREE CATALOG

This new Walworth Lubricated Plug Valve Catalog No. 44L is just off the press. It gives prices, sizes, dimensions, and other pertinent data on this comprehensive line. A request on your company's letterhead will bring you a free copy of this informative catalog.

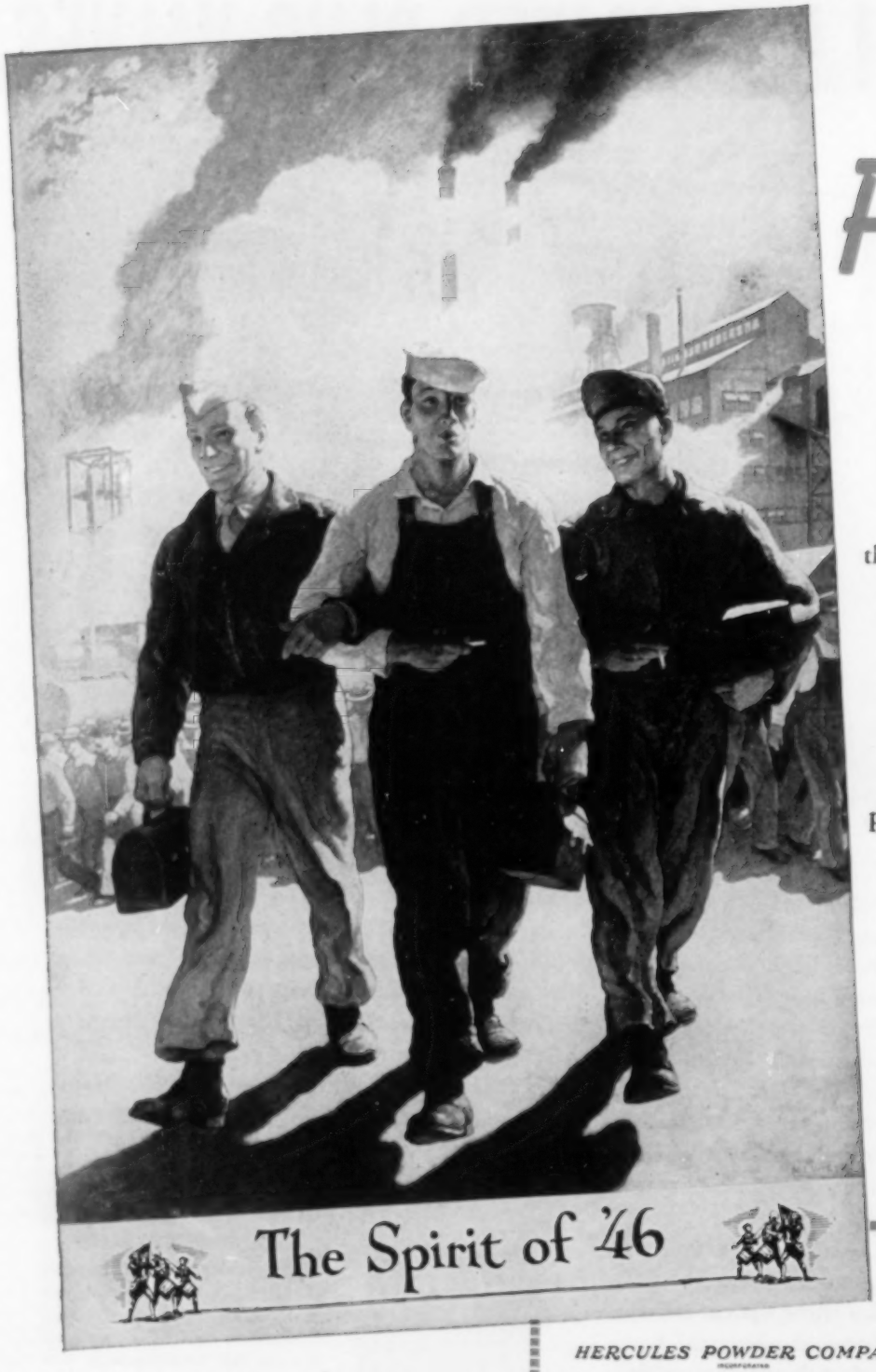
14 AWARDS TO 4 PLANTS

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



FREE!

This beautiful, full-color poster, painted by the well-known illustrator, N. C. Wyeth, is yours for the asking. Printed on heavy paper, size 27½" x 43½", this attention-compelling poster is ideally suited for posting in industrial plants and offices.

RETURN COUPON FOR YOUR COPIES NOW!

HERCULES

CHEMICAL MATERIALS FOR INDUSTRY

HERCULES POWDER COMPANY *932 King St., Wilmington 99, Del.*

Please send me..... copies of your poster THE SPIRIT OF '46. I understand that this places me under no obligation whatsoever.

*Name*_____

*Title*_____

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IN-223

Leather Belting

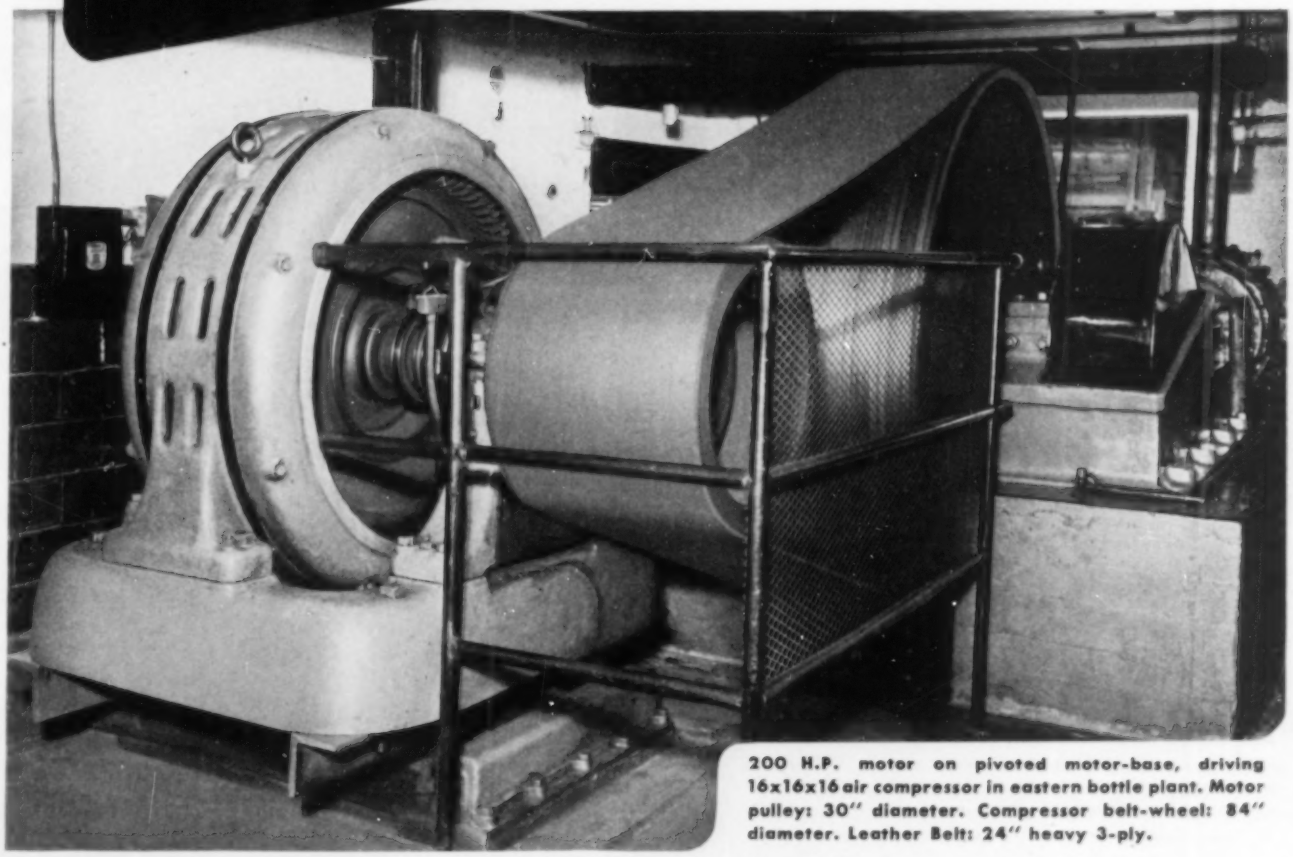
DOES THIS JOB BEST

ENGINEERS AGREE . . . that continuous, trouble-free power-transmission demands the proved advantages of the Short-Center, Flat Leather-Belt, Pivot Motor-Base Drive.

Plant after plant has learned the facts in regard to belting. On hundreds of compressors, leather belts last longer, deliver more power, for less.

Leather is a *natural* for many types of installation, pays-off in low maintenance, uninterrupted performance. When flat leather belting is installed on a short-center drive using a pivoted motor-base, proper belt tension is automatically maintained year after year.

For long, low-cost power-transmission, leave it to leather!



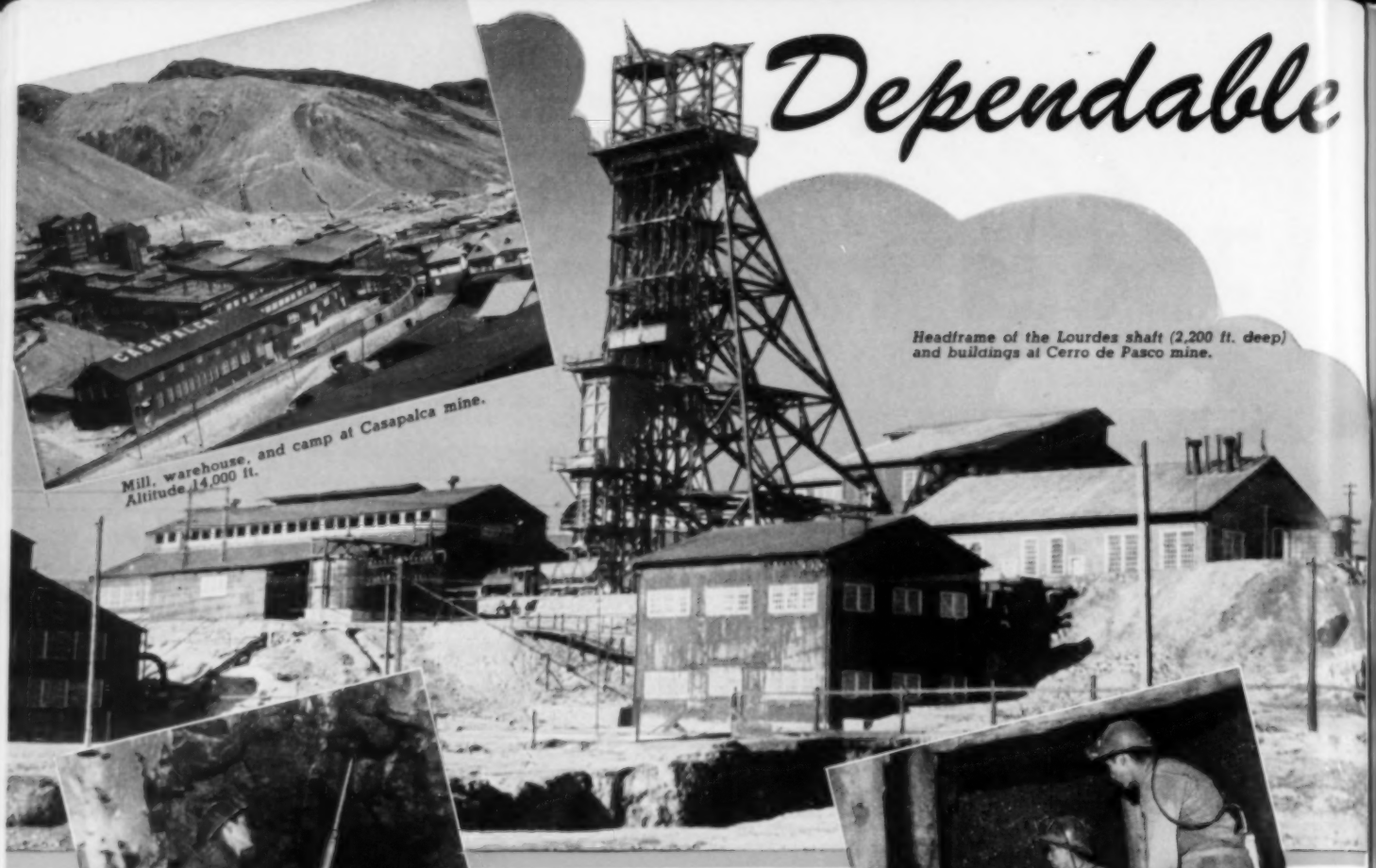
200 H.P. motor on pivoted motor-base, driving 16x16x16 air compressor in eastern bottle plant. Motor pulley: 30" diameter. Compressor belt-wheel: 84" diameter. Leather Belt: 24" heavy 3-ply.

Leave it to Leather!

AMERICAN LEATHER BELTING ASSOCIATION · 41 Park Row, NEW YORK 7, N. Y.

Dependable

Mill, warehouse, and camp at Casapalca mine. Altitude 14,000 ft.



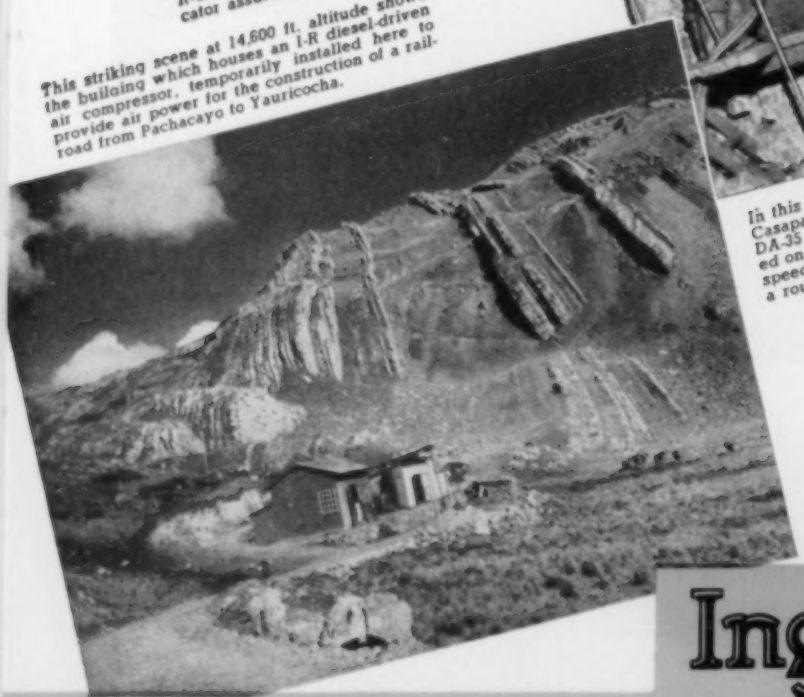
Headframe of the Lourdes shaft (2,200 ft. deep) and buildings at Cerro de Pasco mine.

Cut and fill stoping at Morococha mine with an R-48 Stopehamer. The use of an air-line lubricator assures adequate oil for the drill.

Vital coal comes from the Goyallarisquisqa mine. Holes are drilled with the popular JA-35 Jackhamers.

In this heading at the Casapalca mine, two DA-35 Drifters mounted on a horizontal bar speed the drilling of a round.

This striking scene at 14,600 ft. altitude shows the building which houses an I-R diesel-driven air compressor, temporarily installed here to provide air power for the construction of a railroad from Pachacayo to Yauricocha.



This Drill Steel Sharpener is typical of a number of such units in service throughout the Cerro de Pasco properties. I-R sharpeners and oil furnaces are depended upon for properly forged bits and shanks.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS · ROCK DRILLS · AIR TOOLS · BLOWERS · PUMPS · ENGINES · HOISTS · VACUUM EQUIPMENT

Offices and Agents in Mining Centers the World Over

Performance is a "MUST"

at CERRO DE PASCO Copper Corporation in the lofty Andes of Peru

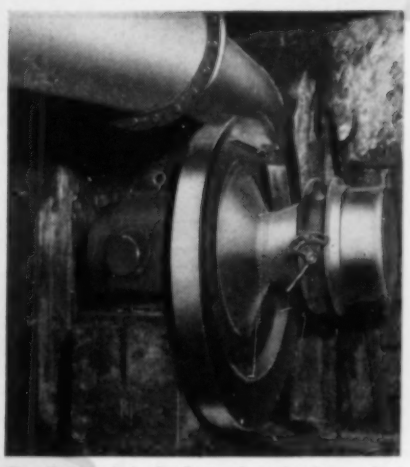
Rich mineral veins in the massive Peruvian cordillera—ancient land of the Incas—lured Spaniards to this region in the 16th century. Fabulous treasures of gold and silver were mined from these mountains for more than 200 years thereafter, much of it accomplished by means of forced Indian labor.

Nearly 400 years later, minerals from this same rugged range provided notable assistance to the United Nations in the fight for freedom.

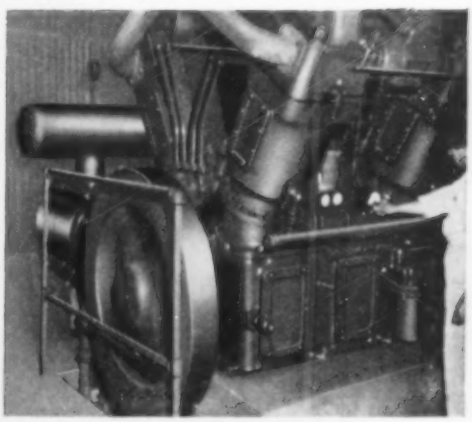
The development of large-scale production of copper, lead, zinc, silver, gold and other metals by Cerro de Pasco Copper Corporation is truly an epic of our time. Men of vision and great determination gradually overcame the tremendous obstacles of transportation, the rugged terrain at extreme altitudes, the absence of fuel, and other discouraging problems.

In making mining history, the Cerro de Pasco Copper Corporation is led by men who are progressive in their thinking. They believe in mechanized methods and the advantages provided by modern mining equipment. In their plans for further development of this unique enterprise, dependable machinery is a "must."

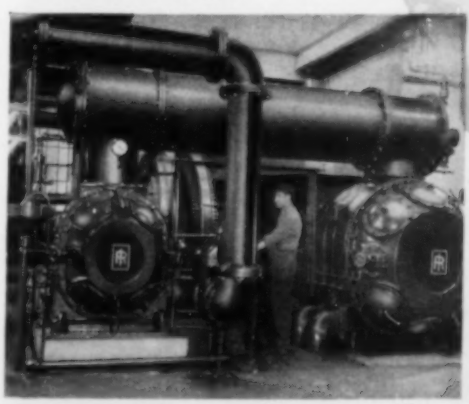
Compressed Air for tunnel work at the new Seria Hydroelectric power plant near Yauricocha is supplied where it is needed by this MOBIL-AIR compressor.



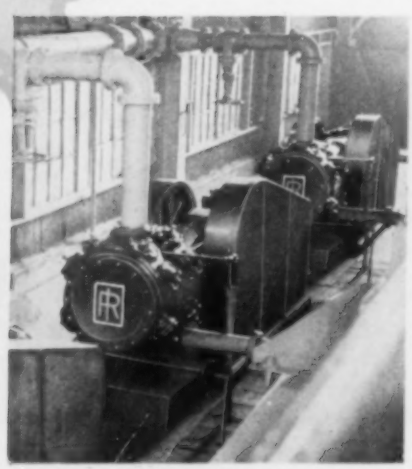
Ventilation air in the Casapalca mine is supplied at the rate of 10,000 cfm by this compact I-R Motorblower. Larger, multi-stage blowers furnish low pressure air for flotation at the concentrators.



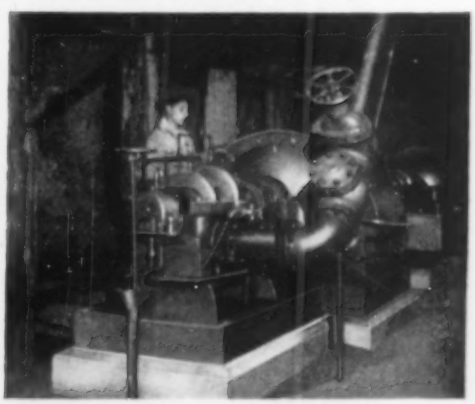
At 15,000 ft. altitude this Type XVO diesel-driven compressor furnishes air power at the Yauricocha mine pending completion of the Seria Hydroelectric plant.



This large, duplex air compressor at the Oroya smelter is typical of the I-R electric-driven units which have given dependable service at Yauricocha, Goyallarisquisga, Casapalca, Morococha, and Cerro de Pasco.



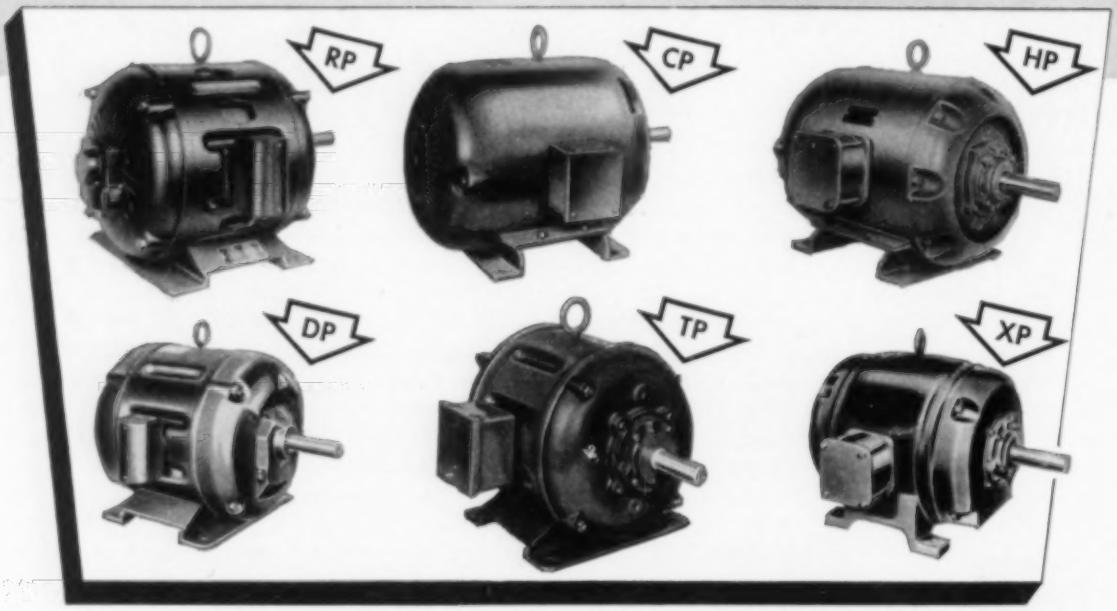
Two of three I-R heavy-duty vacuum pumps installed at the Cerro de Pasco concentrator. The use of belt guards is in keeping with rigid safety policies.



This modern two-stage centrifugal pump is one of two I-R units installed underground at Cerro de Pasco mine. Drinking water and water supply for the concentrator are delivered to the surface. Various sizes of I-R pumps are in service at other properties.

14-787

Wagner offers a Complete Line of Motors for all Industrial Applications



Wagner motors (shown here in their electrical and mechanical variations) embody the latest developments in design. They are simple, rugged and dependable and have long life in addition to good electrical performance.

The tables below show the electrical and mechanical types of Wagner polyphase squirrel-cage and wound-rotor motors available for industrial applications.

ELECTRICAL TYPES OF WAGNER POLYPHASE MOTORS

Type	Ratings	Electrical Characteristics	Applications
RP-1	1-10 to 400 hp 3- and 2-phase 25 to 60 cycles 110 to 2300 volts	Normal Torque—Normal Slip	Group or individual drives on machine tools, fans and blowers, compressors, centrifugal pumps—on any applications where normal-torque motors are satisfactory.
RP-5	1½ to 100 hp 3- and 2-phase 60 cycles 110 to 2300 volts	High Torque—Normal Slip	Crushers, plunger pumps, belt conveyors starting under load, large air compressors, large refrigerating machinery, mixers, and other applications requiring high starting-torque.
RP-6	½ to 150 hp 3- and 2-phase 25 to 60 cycles 110 to 2300 volts	High Torque—High Slip	Punch presses, shears, metal-drawing operations, balers and other machinery equipped with flywheels or having flywheel effect.
RP-7	1 to 50 hp 3- and 2-phase 25 to 60 cycles 110 to 550 volts	High Torque—High Slip	Elevators, cranes, hoists, dumbwaiters.
RS-1	1 to 250 hp 3- and 2-phase 25 to 60 cycles 110 to 550 volts	Continuous Duty—constant and adjustable varying speed	Conveyors, compressors, pulverizers, etc., requiring continuous operation.
RS-2	2 to 200 hp 3- and 2-phase 25 to 60 cycles 110 to 550 volts	Intermittent Service—Crane and hoist duty	Elevator, crane, hoist, and like services which operate intermittently.

MECHANICAL TYPES OF PROTECTED AND ENCLOSED SQUIRREL-CAGE MOTORS

Type	Ratings	Mechanical Characteristics	Applications
CP	1½ to 125 hp 2- or 3-phase 25 to 60 cycles 110 to 2200 volts	Totally-Enclosed Fan-Cooled	Locations where dust, filings, fumes, moisture, and other abrasive and corrosive agencies shorten the life of open-type motors.
HP	¾ to 125 hp 2- or 3-phase 25 to 60 cycles 110 to 2200 volts	Explosion-Proof	For Class 1 Group D locations involving flammable volatile liquids, highly-flammable gases, and other highly-flammable substances.
TP	¼ to 15 hp 2- or 3-phase 25 to 60 cycles 220, 440, or 550 volts	Totally-Enclosed Nonventilated	(The equivalent of type CP, but in smaller ratings not needing external fan cooling.)
DP	¼ to 5 hp 2- or 3-phase 25 to 60 cycles 110 to 550 volts	Dripproof	Locations involving dripping liquids and falling metal chips and other particles.
XP	¾ to 50 hp 2- or 3-phase 25 to 60 cycles 110 to 550 volts	Splashproof	For outdoor and indoor locations where motors are subjected to splashing liquids.

M45-21

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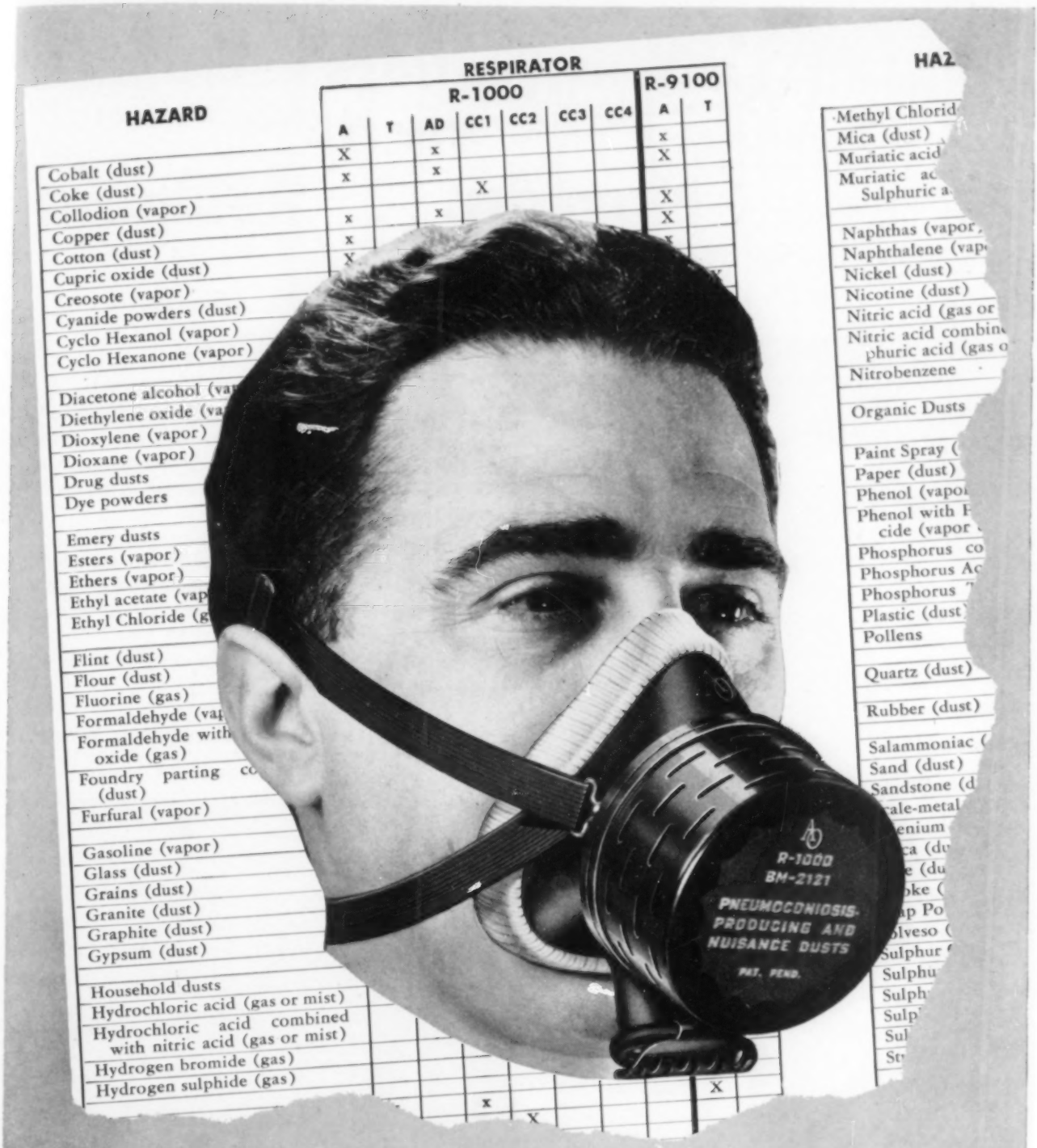

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PICTURE

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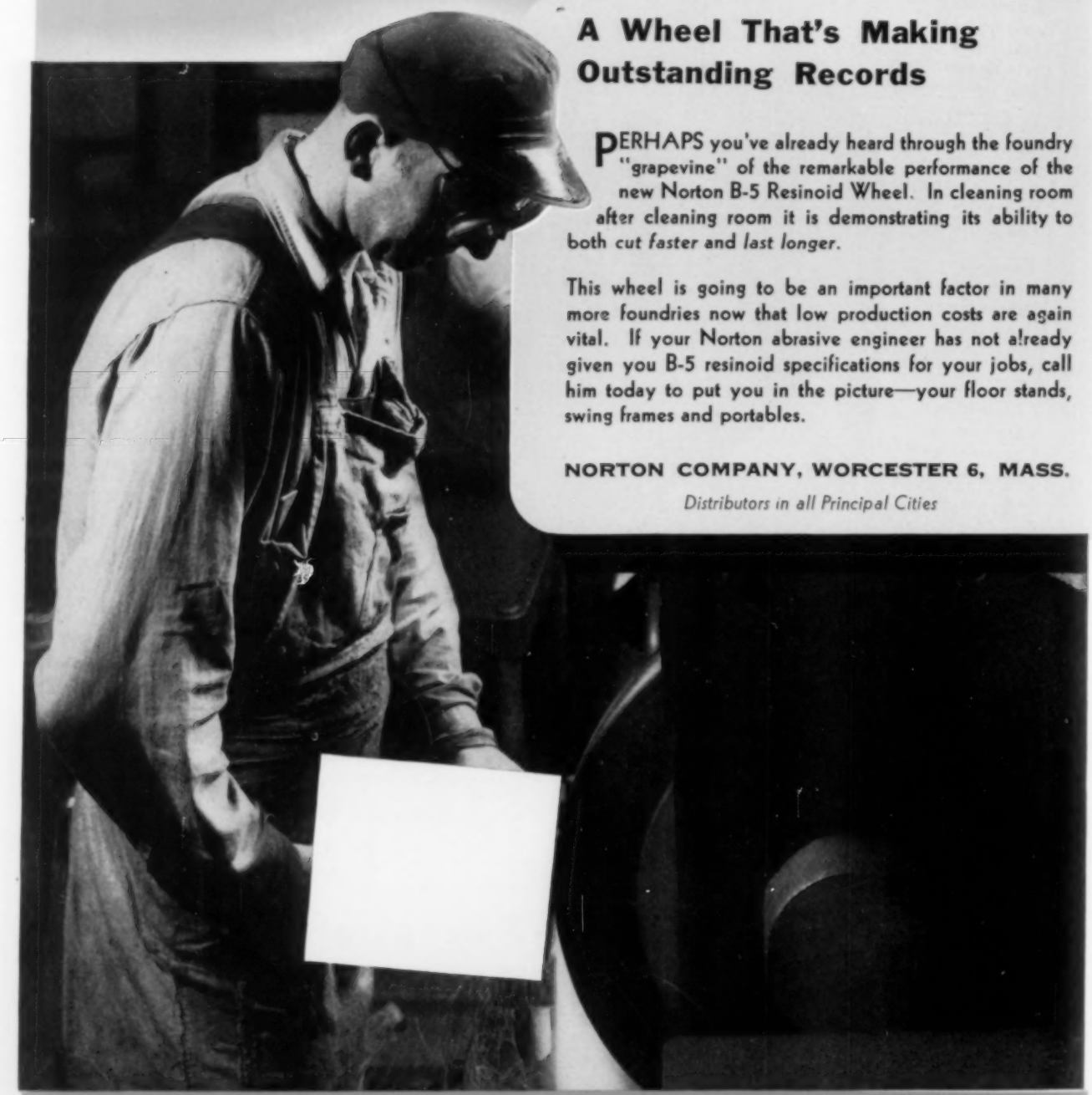

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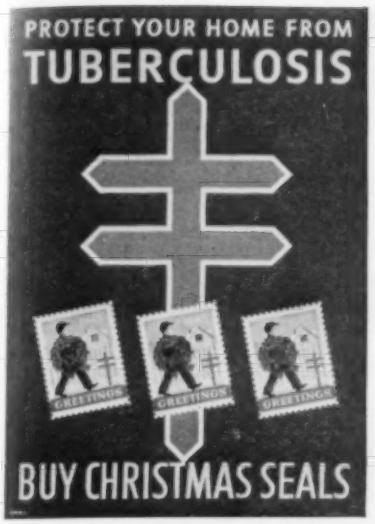

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ON THE COVER

OUR cover picture shows a naval gunner training the sights of an antiaircraft weapon on an enemy plane. Within the boxlike backsight, a tiny gyroscope, spinning at around 10,000 rpm., controls the mechanism that automatically aims the gun with correct allowance for the "lead" of the target. The gyro is whirled by compressed air circulating through plastic tubing in a closed circuit that excludes oil and moisture.

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IN THIS ISSUE

ALTHOUGH thousands of miles from home bases, our battlecraft in the Pacific were never far from adequate service and repair facilities, thanks to the marvelous floating dry docks of different types that were developed by our Navy and described in our first article.

•

IN THE era now dawning, airfields will be prominent features of suburban landscapes. Airport construction is already on a highly organized basis, as is made plain in the article that begins on page 315.

•

BULK-DISTRIBUTION plants are one link in the extensive system that moves petroleum products from wells to users at low cost. One of the most modern bulk stations yet built is operating in Detroit. See page 324.

Compressed Air Magazine

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VOLUME 50 **December, 1945** NUMBER 12

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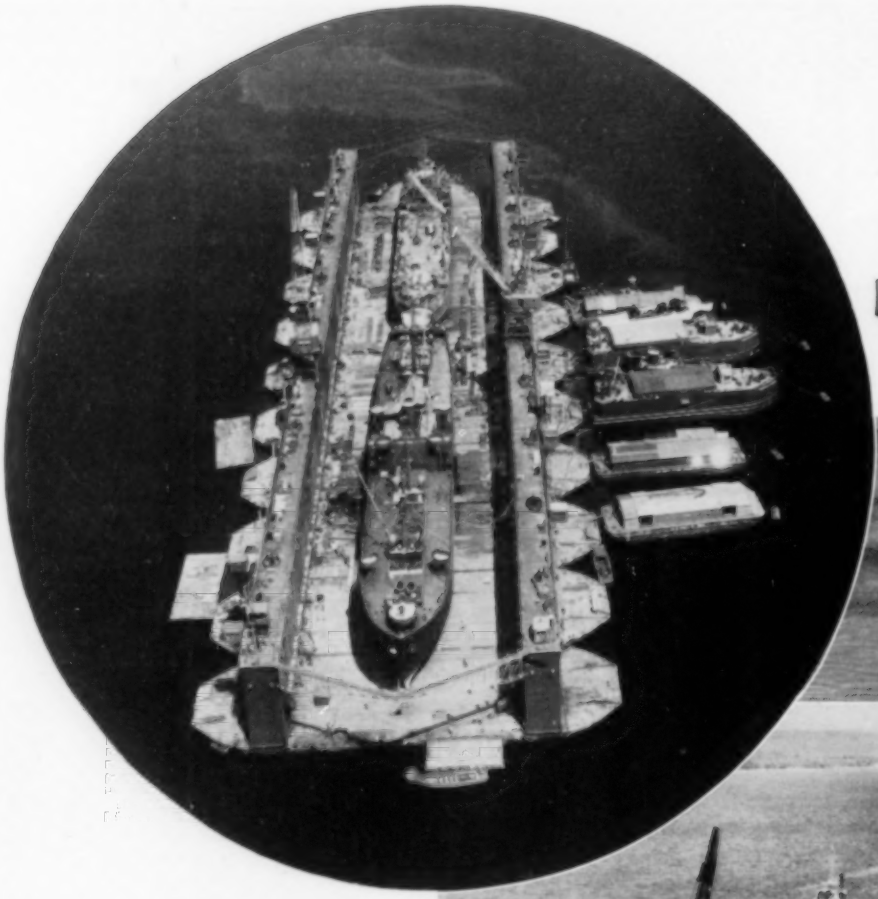
Published by Compressed Air Magazine Co., G. W. MORRISON, *President*; C. H. VIVIAN, *Vice-President*; J. W. YOUNG, *Secretary-Treasurer*
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York 4, N. Y., L. H. GEYER, representative.
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index.



They Also Served

The Story of Our Navy Floating Dry Docks

R. G. Skerrett

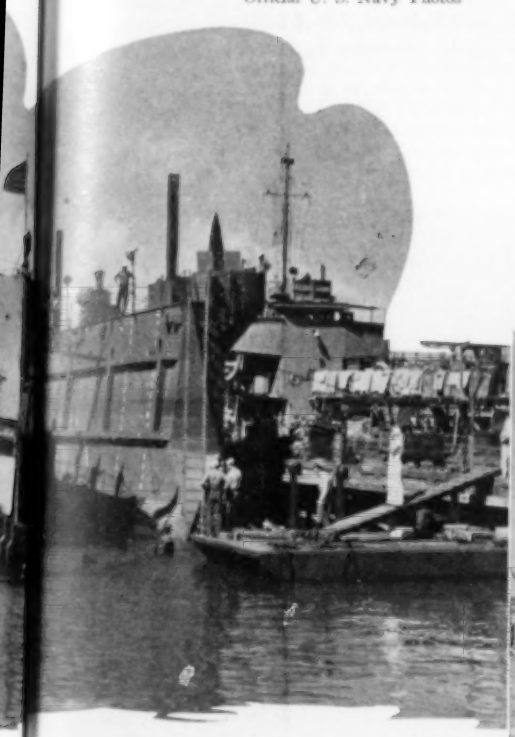
IN HELPING to win victory in the Pacific, our Navy was faced with a task that was fraught with many difficulties because our battlecraft had to operate far from home bases and their sources of supplies.

Much has been told about the spectacular performances of our battleships, aircraft carriers, powerful cruisers, and the "silent service" of our submarines, not to mention the dash of our diminutive PT boats, veritable cockleshells of high speed and sinister striking power. But back of this formidable array there was a noncombatant force that offset in large measure the handicaps under which our fighting ships had to carry on their ever-widening and persistent advances. Among these unheralded aids were numerous floating dry docks of sundry types and sizes—something of which the Navy never had had more than a few at best during the long years of its gradual development.

Under wartime pressure our battle fleet grew at an astonishing rate. On July 1, 1940, it numbered 383 combatant craft aggregating 1,313,390 tons, with 49 other warhips building. On July 1, 1945, the active Navy was made up of 4,433,-418 tons or about 1200 combatant vessels and of more than double that tonnage in auxiliaries and special floating facilities of different kinds.

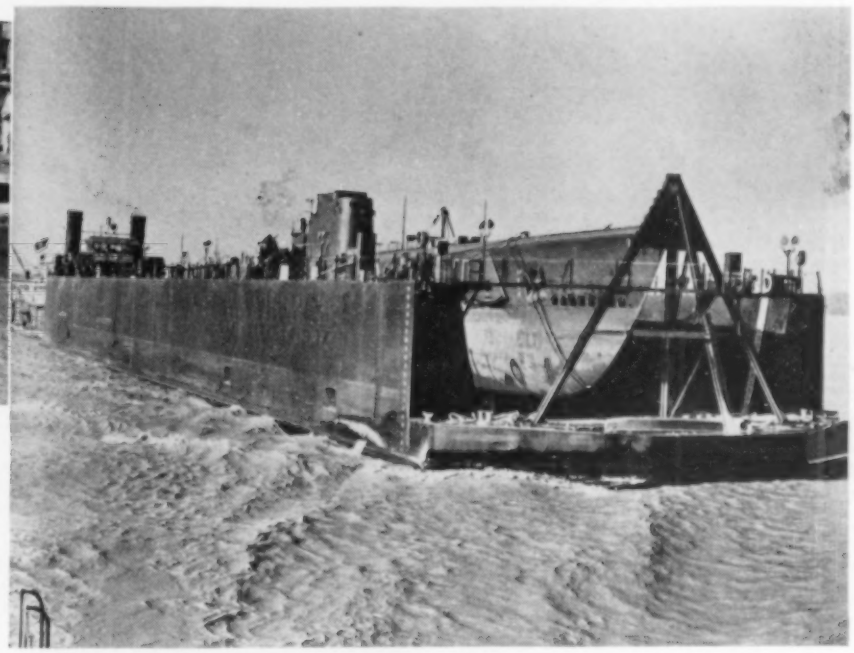
Battlecraft, transports, tankers, and freighters all need periodic docking to permit cleaning and painting their bottoms, as well as inspection and proper maintenance of propellers and underwater fittings. These are routine services in time of peace; but under stress of warfare the demand for attention, upkeep, and repairs is multiplied. Foresight luckily made vital dry docks available where they could be easily reached especially by damaged craft so that they could return to the battle zones with the least delay. In reference to this matter the Navy Department has said: "Experience has verified the old statement that the cheapest and quickest way to build a ship is to repair one already built." Because of this procedure, we repeatedly surprised the enemy by again

Official U. S. Navy Photos



VARIED SERVICES OF NAVAL DRY DOCKS

The several types of dry docks that were built during the war materially helped our Navy to achieve success. Most spectacular and most helpful were the advance-base sectional docks—the ABSD's—which were assembled in the western Pacific to serve as repair bases for damaged fighting ships that would otherwise have had to be returned to shore bases for attention. In one 8-month period docks of this type handled 176 ships. Their size is attested to by the two pictures at the extreme left. They show 10-section ABSD's with two vessels receiving attention simultaneously (top) and a major battelship being put back in service condition (bottom). Both have auxiliary craft moored alongside to supplement the repair facilities built into them. Smaller docks are illustrated in the other views. In the center one a PC boat is resting in an auxiliary repair dock. Some dry docks were used as transports. One is shown below moving the submarine "Peto" down the Mississippi River to the Gulf of Mexico. Built at Manitowoc, Wis., the "Peto" was the first submergible ever to be constructed on an inland waterway.



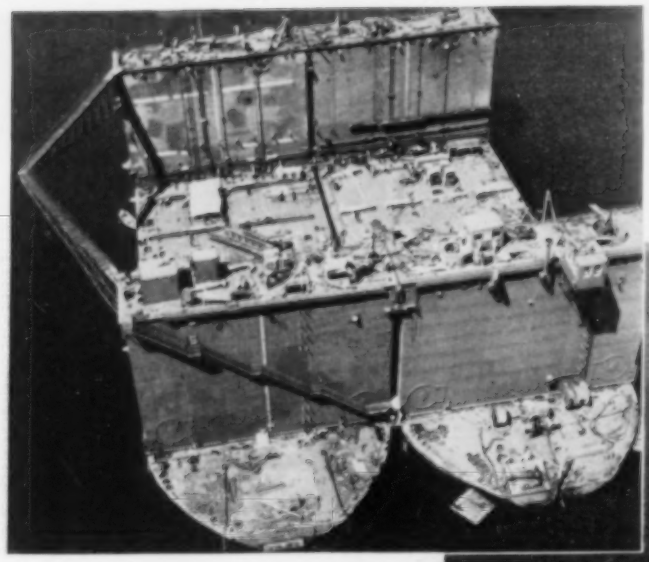
placing in action vessels so injured by him that they were assumed to be total losses. This could not have been done had we not had ready a sufficient number of dry docks. How we provided them is one of the wonder stories of World War II.

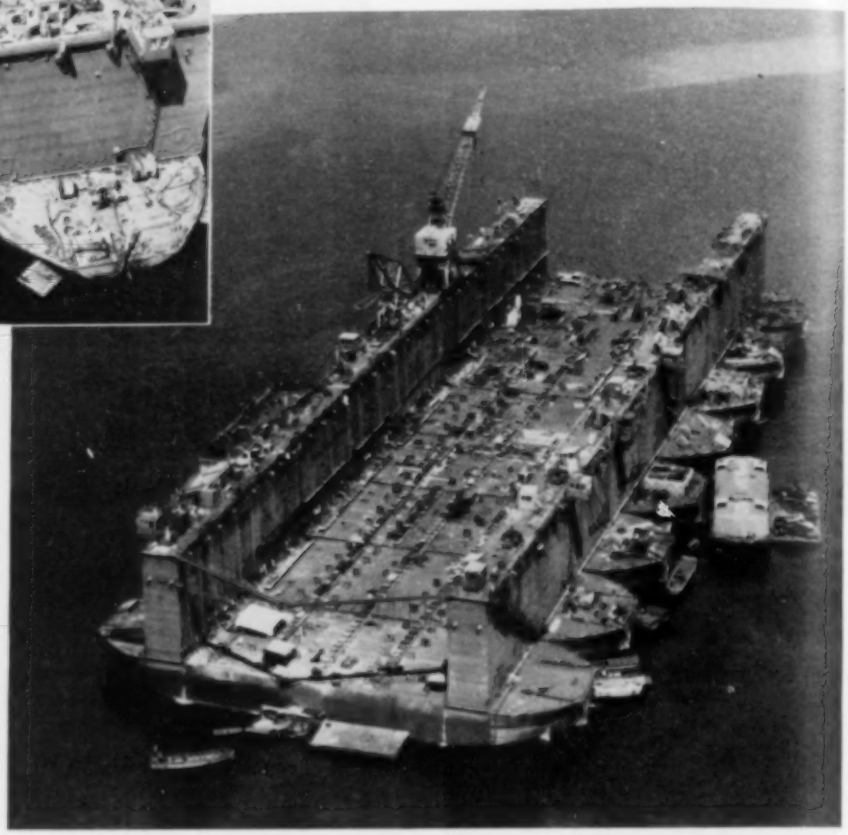
As recently as March, 1939, a representative of the Chief of Naval Operations informed the Committee of Naval Affairs of the House of Representatives: "The situation confronting the Navy with respect to adequate docking facilities is of serious concern to the national defense. Docking facilities on the West Coast and in Hawaii are now inadequate to meet the needs of the existing fleet in time of peace." A year later, as if tempting fate, virtually the entire battle fleet was engaged in maneuvers in the Pacific. It was well for us that the Japanese did not strike until December of 1941, by which time steps had been taken to overcome our shortcomings.

In 1938, the Bureau of Yards and Docks made a comprehensive study to ascertain the extent of our deficiencies in dry docks on the Atlantic and Pacific coasts and in the Hawaiian Islands. While this article is intended to deal primarily with our new floating dry docks, it is not amiss to mention what was done by us to equip our naval stations with large graving docks to meet our defensive needs prior to our entry into the recent conflict. In their case we resorted to novel methods of construction, and among them was the placing of immense volumes of concrete underwater. That departure enabled us to build graving docks at a much lower cost and more rapidly than ever before, and some of them under soil conditions that would previously have been considered "prohibitive." At Pearl Harbor a great dock of that kind was finished in about twenty months—a year ahead of schedule—and was ready for service when the Japanese attacked. It is about 50 percent larger than the first one constructed there and which, because of difficult ground conditions, had collapsed and required six years to bring it to completion. Other huge graving docks were provided on the Pacific Coast and at the Navy yards in Norfolk, Philadelphia, and New York. The one at the latter base was built in twenty months, as compared with eight years for a structure about half the size.

The Navy's dry-dock construction program has been underway since 1940 and has called for 183 units at an estimated cost of $511,000,000. Of that sum $300,000,000 has been allotted for the building of highly mobile types of floating dry docks, many of which can be towed at goodly speeds. They range from those designed to handle small cargo craft to those capable of ministering to battleships, aircraft carriers, and other big combat units.

Our national naval establishment came into being in 1775, but not until 1834 did we have any dry docks at our navy yards. That year money was appropriated for two masonry-lined graving docks, one at Boston, Mass., and the other at Norfolk, Va. By that time the lack of government dry docks had become a matter of alarm. When the wooden fighting ships of that period had to be freed of barnacles and marine vegetation—which cut down their sailing speeds and military value, or when worm-eaten planking had to be replaced and the copper sheathing below water needed repair or renewal, the vessels were commonly hove down in shallow water at high tide and careened to expose the bottom first on one side and then the other so that the work could be done at low tide. Heaving down was a laborious and tedious operation and not infrequently caused serious structural straining and sometimes deformation. Tidal and weather conditions determined when the job could be undertaken. The graving dry dock was the remedy and was believed by naval authorities to be best suited for the service. But the fertile mind of the engineer did not rest there, and in time floating dry docks of





EVOLUTION OF AN ABSD

Advance-base sectional dry docks were towed thousands of miles to forward fighting areas in separate sections that were then joined to form structures of varying sizes. Shown at the left are two units, each of 10,000 tons lifting capacity, tied together. Others were added as they arrived. Below is pictured an 8-section dock nearing completion. One of its side-wall cranes is already erected.

several types were conceived and built.

The seafaring fraternity is traditionally conservative, and naval men were notably so in the past. The floating dock was reluctantly recognized only after some years of rather biased academic discussion. Beginning in 1845, Congress, the Navy Department, and a special board organized by the Secretary of the Navy had under advisement the construction of two more dry docks, and the bone of contention was whether or not one of them should be of the floating type of which several were then being operated by private concerns in the Port of New York for merchant craft. The naval board favored graving dry docks, although they acknowledged that the floating dock answered very well for mercantile ships. One objection to the floating dry dock was that it lacked the permanency of a masonry structure. Economy finally outweighed the various criticisms, and a wooden one of the balanced type was ordered for the Portsmouth Navy Yard. It was ready for service in 1851 and had a lifting capacity of 1500 tons—which was ample for many of the naval vessels of those days. That dock was in use for half a century.

From 1851 on, the Navy added to the number of its dry docks as our fleet increased and the major ships became larger and outgrew the capacities of the existing structures. From 1889 to the end of 1897 most of the new docks were of wood—the very material that had been called "perishable" when the first of the floating dry docks was under consideration. Then came the upbuilding of the "New Navy" with its vessels of steel, and as they steadily increased in size one after another of the graving docks became inadequate.

When the first of our coast-line battleships, the *Indiana*, was ready in 1895 to run her acceptance speed trial, she had to be put over the measured course with a foul bottom because we had no dry dock big enough to accommodate her. Two years later the same ship, with her bottom still more thickly covered with barnacles and marine vegetation, had to be sent to Halifax, Nova Scotia, to have her underwater surfaces cleaned and painted because she could not make her designed speed even when burning a costly excess in coal. That was just one year before the Spanish-American War. Congress got busy during 1897-98 and provided more dry docks of ample capacity. Among them was a floating dock of steel to be located on the Mississippi at Algiers, La., 100 miles up from the Gulf of Mexico and opposite New Orleans. The design was furnished by an English firm that had specialized in the type, which had undergone great improvement in Europe where it was in wide use.

The Algiers dry dock was a self-docking structure that could successively raise its several sections clear of the water and lift a vessel of 16,000 tons displacement. It was built by the Maryland Steel Company at Sparrows Point, Md., and left the shipyard on November 6, 1901, under tow, arriving at Algiers 21 days later. The dock remained at that naval base for 39 years, and then the Navy Department decided to move it to Pearl Harbor where it could be of much more use. In the spring of 1940 a private company towed the structure to the eastern entrance of the Panama Canal. There it was separated into three sections to permit passage through the locks. At Balboa the dock was reassembled and strengthened for its sea run of nearly 4800 miles.

The flotilla for that trip, besides the dock, was made up of the naval cargo ship *Capella*; the *Navajo*, a powerful diesel-electric tug; and the *Platte*, a new tanker that carried extra fuel and gear to enable her to help the *Capella* and the *Navajo* tow in an emergency. The expedition left Panama Roads on July 10 and reached Pearl Harbor 44 days later. The average rate of speed was 4.5 knots, which was made possible by the dock's tapered bow and stern pontoons that also contributed to its steady motion in a seaway. But the craft's high sides, which presented expansive sur-

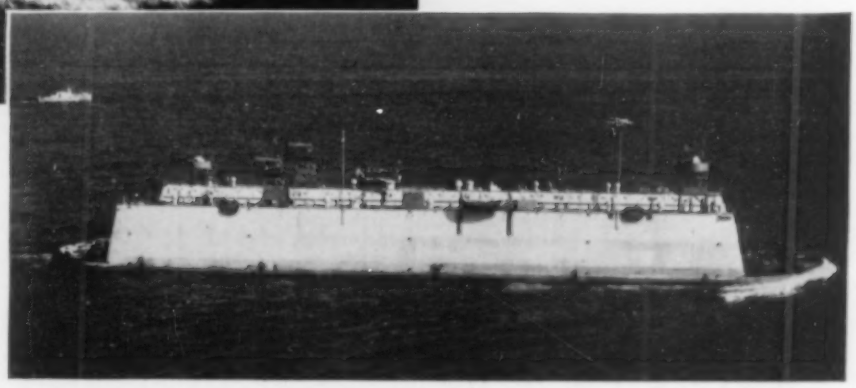
faces to the winds, and its relatively light draft caused it to swing sidewise off the course and to advance crablike to the pull of the towline.

At the same shipyard was constructed the floating dry dock *Dewey* for our naval station at Olongapo in the Philippines. That dock was a rectangular structure 500 feet long, 130 feet wide, and 18 feet deep, and had side walls 45 feet high that extended almost the length of the pontoon sections which formed the sustaining hull. It was completed in 1905 and started its overseas voyage of 13,089 miles on December 28 of that year. The towing vessels were three in number, and the course entailed a winter crossing of the North Atlantic to the Straits of Gibraltar and thence through the Mediterranean, the Suez Canal, and the Red Sea into the Indian Ocean—a run that took 150 days and 9 hours. The average daily progress was slightly more than 87 miles, but at times in the Atlantic progress was negative when the dock broke away from the ships and drifted westward before the wind. On one occasion the lumbering, towering craft was blown on a vagrant course for 100 miles before she could be caught up with and held under the restraint of the towline. That trip was a difficult and dangerous one, and it still remains a source of wonderment how those responsible got her to the journey's end. The purpose in referring to the *Dewey* and the Algiers dry dock is to illustrate some of the difficulties that had to be taken into consideration when designing the new floating docks, which also had to be moved long distances over possibly stormy waters to points remote from our shores where they could be of service to our fighting ships.

In the past, floating dry docks have been stationed in harbors and have been shifted but infrequently. Most of their movements have been vertical in submerging to receive a vessel and in rising by discharging water ballast to lift the berthed craft out of the water to make repairs. With that work completed, water ballast is once more admitted to the dry dock's tanks to cause it to sink and thus refloat the ship. In what follows about the Navy's new floating dry docks it will become clear that they vary widely in design and size to handle fighting craft and naval auxiliaries of different sorts and tonnages. Some have operated at naval bases in this country and elsewhere within our domestic waters—have been moved up and down our rivers and waterways sometimes to transport vessels that could not travel under their own power because of incompletion or the shallowness of the channels that had to be navigated. Others have been towed long distances across oceans to advanced bases. The keynote of all these structures has been adaptability to meet the changing needs of wartime and the ravages of heavy seas and violent winds.

Experts in many fields of engineering have given of their best in evolving the design for each type of our floating dry docks, as well as in testing the models, planning the equipment, and in building them. Fortunately, the Bureau of Yards and Docks has foreseen what we might require and did some pioneer work on a full-size scale that proved invaluable when we became involved in a world-wide conflict. The new docks are constructed mainly of steel, but the planners did not hesitate to substitute timber where that could be done without inviting structural shortcomings. Definite economies have been realized by combining these materials and by recourse, in some cases, to concrete, departures that have been marked by much ingenuity and that may have much peacetime value.

A floating dry dock is itself a vessel, and most of the earlier types are boxlike in form and made up of one or more submergible pontoons which constitute the central supporting hull and of upright wing walls at opposite sides. The pontoons are internally subdivided into tanks to receive water ballast and to restrain the fluid so as to limit surging as



ON ITS WAY TO WAR

Two views of an ARDC—an auxiliary repair dock of concrete—en route to naval operations in the Pacific. Most dry docks have to be towed, but this type is self-propelled. The aerial picture shows the keel blocks that can be adjusted as required to support the ship being serviced.

a dock sinks or rises when water is admitted or discharged. Some of the new floating dry docks are basically of this design, but others are radically different in get-up and in their ways of working. They are the ones that were designed "to go places," and they have surely done so. They have been invaluable both to us and to our Allies in distant sea areas as first-aid stations either in making damaged ships fit again for active duty or in patching them up sufficiently for the long trip to a port for restoration. During the Okinawa campaign covering three months, when 218 of our fighting craft, transports, and freighters were injured and 35 were sunk, our docks in the western Pacific met the emergency and enabled us to maintain pressure upon the foe.

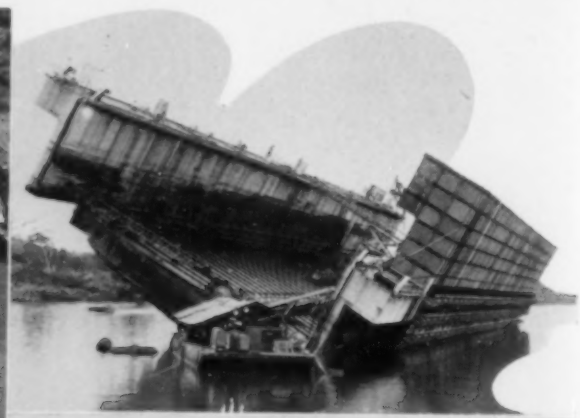
The Navy's floating dry docks may be divided broadly into four classes, with some subtypes designed for particular purposes. The major groups are: advance-base docks, consisting of a single unit or section and officially known as ABD's; advance-base sectional docks—ABSD's—composed of a number of ABD's; auxiliary repair docks or ARD's built of steel and having shipshaped hulls; and yard floating docks—YFD's—which are usually assigned to a shipbuilding, repair, or navy yard, or to some other base for stationary service. In addition there are ARDC's, auxiliary repair docks of concrete construction, and steel auxiliary floating docks, officially dubbed AFD's.

Back in 1937, the Bureau of Yards and Docks designed ARD's of two sizes that differed essentially from the box-like type. One was to have a length of 446 feet and a beam of 68 feet; the other was dimensioned to accommodate the great aircraft carriers *Lexington* and *Saratoga* and was to be 1016 feet long, to have a beam of 165 feet, and to be 75 feet high from keel to top of the side walls. Each was to be built in one piece like the body of a ship for long and speedy towing. It was to have a pointed bow, a stern gate that could be dropped or raised like the tailboard of a truck, and, though not self-propelling, to be equipped with steering gear. Congress did not appropriate enough money, so only the smaller of these unusual docks was constructed.

Under the 1940 program a considerable number of steel ARD's was provided. They have an over-all length of 490 feet, a beam of 81 feet, and can take the biggest of our destroyers. The double-walled sides are the counterpart of the wing walls of the conventional floating dry dock and are permanently united to the central structure which serves the same purpose as the pontoons of the earlier type, the space between the bottom and the floor being subdivided into ballast tanks, as are the lower sections of the flanking walls.

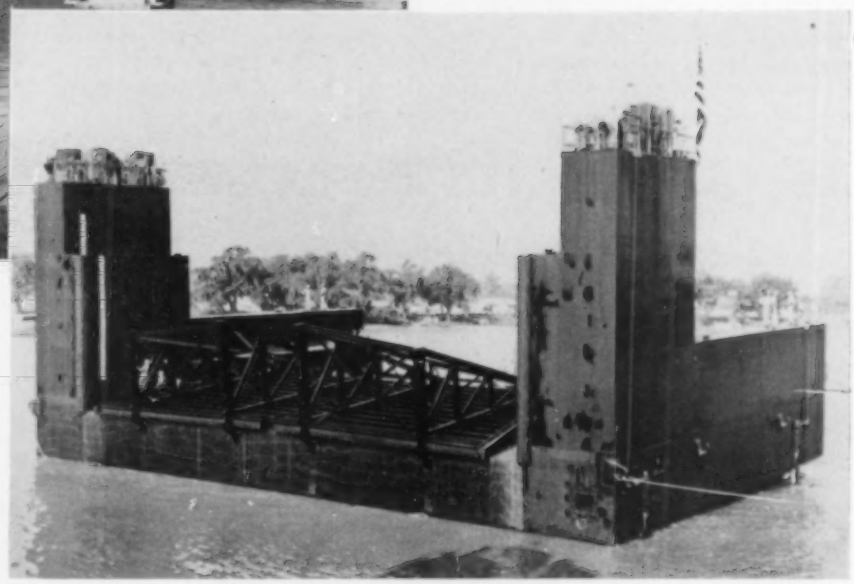
The sinking and raising of an ARD is controlled by the admission or discharge of water ballast; but first the docking space or trough must be partly flooded by dropping the hinged stern gate. Then the dock can be submerged by pumping the necessary ballast into the tanks. When a ship has entered and is centered over the keel blocks and held in position by shores at each side, the stern gate is closed and only enough water is pumped out of the tanks to raise the dock sufficiently to drain the trough. With the craft repaired, the basin is again flooded and water is admitted into the ballast tanks to cause the structure to settle deep enough to float the vessel clear of the keel blocks. Then the stern gate is opened so the ship can be withdrawn.

Quarters for a complement of 107 officers and men are provided in the upper sections of the side walls where they are 10 feet wide. In the lower sections are the diesel generating sets that fur-



GOING THROUGH THE PANAMA CANAL

Faced with the problem of getting a 3-sectional, 124-foot-wide, 18,000-ton YFD through the 110-foot-wide locks of the Panama Canal, the Seabees offered the solution pictured here. Each section was dealt with separately by mounting six tiers of the Navy's adaptable steel pontoons on top of one of the side walls (above). Water was then admitted to some of these pontoons and also to some of the bottom compartments on that side of the dock section, causing it to heel over. The upper-right picture shows it listing 20°. As more water was added it turned still more, finally riding at an angle of 85° on the wing wall with its pontoon extension (right). Unit was returned to normal position by blowing the water out of the pontoons with compressed air and pumping out the compartments. Portable compressors are on the barge in two of the views.



INTERLOCKING SECTIONS OF A YFD

The view at the left shows the center section of an 18,000-ton yard floating dock just after launching. Note the cantilevered parts of the side walls that interconnect with the end sections, one of which is pictured below.

nish motive energy for compressors, for lighting and power circuits, and for the pumps that handle fuel oil and distribute water to the supply lines and fire-fighting equipment. None of the ARD's is self-propelling, but they have rudders that aid materially in steadying them while under tow and when exposed to heavy seas and stiff winds. It is said that some of them have actually taken damaged vessels aboard in the open ocean and carried them to sheltered harbors where they could be repaired.

The reinforced-concrete ARDC's are rectangular in model except for rounded ends. They are open at each end as is the ordinary dry dock, have much the same mechanical equipment as the ARD's, and have comfortable accommodations for officers and crew. These auxiliary repair docks were towed to certain Pacific bases in the battle areas where they rendered excellent service.

Yard floating docks have been constructed of steel, of lumber and steel, or entirely of timber, and the type varies widely in size and with the service assigned them. The largest are capable of handling vessels of 14,000 to 18,000 tons. Docks of this capacity of steel consist of a single central section or pontoon with integral wing walls, and of independent bow and stern sections that are fundamentally alike. The wing walls of the central sections, both fore and aft, are cantilevered so as to interconnect with parts of the side walls of the end sections. This is done so that the latter can lift the midsection clear of the water for self-docking for inspection, cleaning, or repair of the normally submerged surfaces. Further, either of the end sections, when the central section is submerged deep enough, can be swung around and into the trough of the latter for dry-docking. The YFD's are interesting structures, but their diversities are such that space does not permit saying more than that they have been invaluable at their various locations in our domestic waters.

The steel auxiliary floating docks have lifting capacities of 1000 to 2000 tons and are 1-piece craft of the so-called trough type with shipshaped ends to make them easy to tow. They are from 200 to nearly 300 feet long, have an outside width of 64 feet, and a docking space of about 54 feet. The AFD's are self-contained and have internal-combustion engines, electric generators, air compressors, evaporators to supply fresh water, and other essential apparatus. They were taken to remote overseas bases; and while so voyaging their personnels were housed in Quonset huts placed in the trough and mounted on barges so that they could be floated off and tied alongside for auxiliary service.

The most impressive of our wartime floating dry docks are the advance-base sectional type. These are composite structures made up of a number of ship-shaped hulls each equipped with side walls that can be lowered to offer less exposed surface to troublesome winds. The walls are disposed transversely to the longitudinal center line of the supporting hull and are about 55 feet high and 105 feet long. They are hinged at the bottom so they can be laid flat on the deck. Raising and lowering is controlled by hydraulic jacks. When the side walls are "housed," a dock unit can be towed easier and at a speed approaching 10 knots.

Each ABSD unit is a self-sufficient craft and identical in model and mechanical equipment to every other unit composing a dock. Each section has a lifting capacity of 10,000 tons, and any number of them may be assembled to handle a vessel of any given dead weight and length. Seven of them form a cruiser dock, while ten, with an available length of approximately 830 feet, will accommodate the largest of our battleships or aircraft carriers. The spread between the side walls is 140 feet, and the beam of our biggest battleships does not exceed 110 feet. It is even practicable in an emergency to dock a single ABSD unit in a number of companion sections.

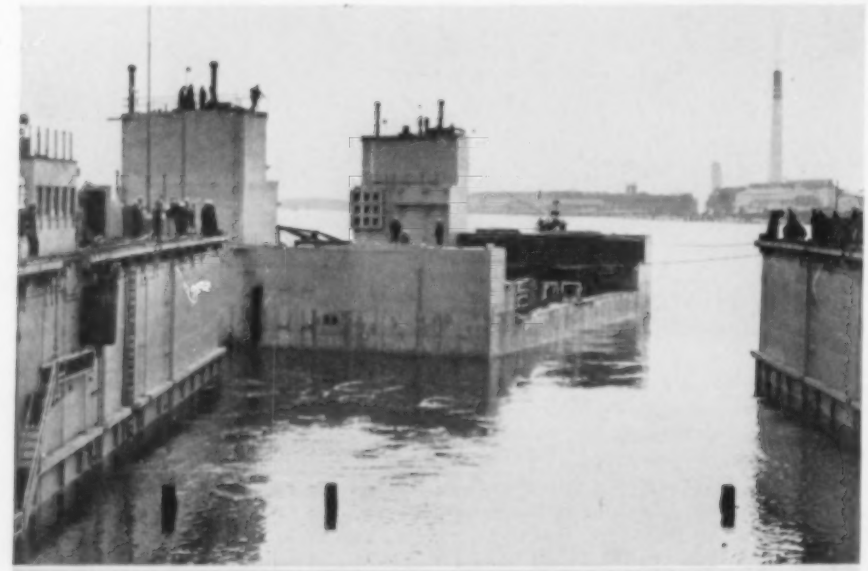
These facts give some idea of the adaptability of the floating dry dock as compared with a graving dock. The volume of water that must be handled in sinking or raising a floating dock varies with the draft of the craft admitted. In the case of a graving dock, the basin has to be pumped dry whether the ship be a destroyer or a monster battle wagon. What's more, a larger volume of water has to be pumped out for a torpedo boat than for a battleship. Further, if a vessel be 1 inch longer than the graving dock it cannot use that dock, whereas ships often have been repaired in floating dry docks that were considerably shorter than they were. Also, a dock of the latter type can raise either the bow or stern of a craft, leaving the remainder

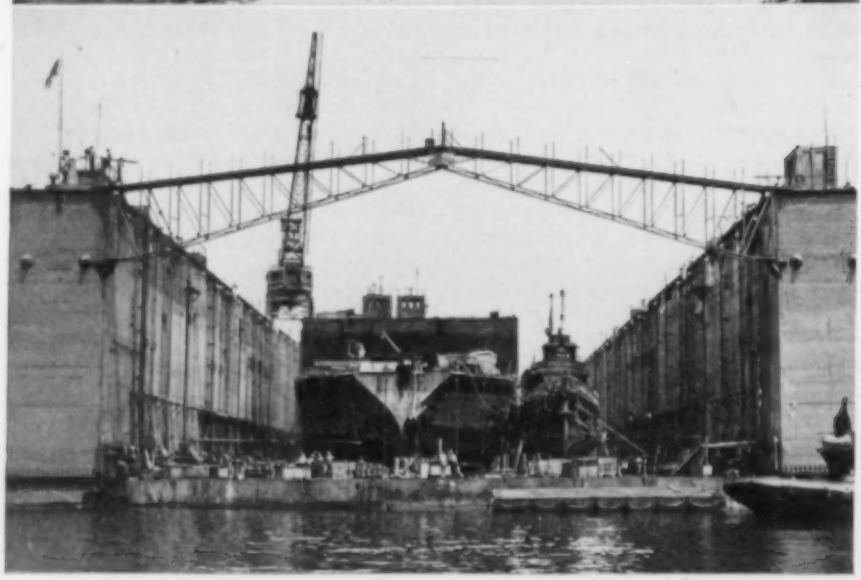
floating upon the outlying water while repairs are in progress.

Dry docks of the advance-base sectional type were designed to be self-propelling, but by reason of emergency restrictions the use of motors, shafting, and propellers was prohibited. The power plant on each unit consists of two Type S diesel engines each direct connected to a 350-kw. generator. They are of the 7-cylinder class with 10½-inch bores and a uniform stroke of 12 inches and develop 520 hp. each. The combined output of the generators, with a power factor of 8/10, is 700 kw., and the current is used to operate the water-ballast pumps and the units that handle fuel oil and maintain the supply in the fresh- and salt-water lines. Each diesel engine obtains starting air from a 5-hp. Type 30 compressor, and the circulating water is cooled by a Type WHE heat exchanger.

Each sectional dock has its own main compressor installation, and it is manifest that an assemblage of ABSD's can furnish a large volume of air. In addition to these units, each cruiser or battleship dry dock carries a portable compressor that is mounted on a skid so that it can be lifted and shifted to any position where it may be needed to provide air for a special purpose. These large-capacity Mobil-Air machines have proved of much value.

The air from the stationary compressor plants is fed into service mains and thence to headers from which it is delivered to subsidiary lines for use in removing rust or marine growths from metal surfaces by sandblasting and in recoating them by spray painting. For repair work, much compressed air is needed to drive riveting and chipping hammers, drills, wire brushes, and the tools required to peen welded seams to insure tightness. Air at a pressure of 100 pounds is intermittently blown into all water, ballast, and oil tanks to free them of gas or foul air; and air acts in connection with the indicators at the control station of the water-ballast system where the man in charge must know exactly how the ballast is distributed in each tank when the dock is either submerging or rising with the added burden of a ship. Otherwise, the dock might quickly assume a serious heel to right or left or trim unevenly from end to end. Besides, compressed air must be available for divers who are often called upon to place with precision the keel and bilge blocks on which a vessel must come to rest when it is lifted out of water. Finally, it has to be used every now and then for the purpose of testing the strength and tightness of the structure while in service.





DOCKING PARTS OF THEMSELVES FOR REPAIRS

An end section of a YFD (top) floating free and being swung around and into the trough of the center section which has been partly submerged for that purpose by admitting water into its ballast tanks. This picture was taken during a test demonstration to illustrate how the ends can be placed in the midsection and lifted out of the water for overhaul. The other view shows an ABSD engaged in servicing one of its own sections and also a sea-going tug that probably moved the unit into the dock.

Splendidly equipped as each advance-base sectional dock is, still the emergency needs of a damaged ship have at times overtaxed its facilities, and that lack is made good by auxiliary docks or barges that have machinery of many kinds on board, including sources of power and compressors.

Our floating dry docks have been handled by officers and crews trained at the Navy's floating-dry-dock school at Tiburon on San Francisco Bay. Some of these specialists have been drawn from the regular naval service, but many have been recruited from the Seabees. The docks were constructed in 28 yards under contracts with 23 firms, and three civilian companies—Frederick R. Harris, Inc., and Construction Management, Inc., both of New York, N. Y., and the Maryland Dry Dock Company, Inc., Baltimore, Md.—were actively engaged in the development of the designs.

In the Navy Department and the Bureau of Yards and Docks, with Vice Admiral Ben Moreell (CEC), USN., chief of the bureau and Rear Admiral L. B. Combs, (CEC), USN., assistant chief, the responsibility of planning the floating dry docks rested on the following officers of the Civil Engineer Corps: Capt. W. H. Smith, USN., Capt. E. H. Prager, USNR., Capt. Kirby Smith, USNR., Capt. W. L. Richards, USN., and Commander J. T. Reside, USNR. During the development work, models were tested in the basins of the University of Michigan, Ann Arbor, and Columbia University, New York City, as well as at the Navy's David W. Taylor Model Basin, Carderock, Md.

Building an Airport in a Hurry

C. H. Vivian

DRILLING 20-FOOT VERTICAL HOLES

Shown above are five of the 46 Ingersoll-Rand Type FM-2 wagon drills on the job, a number that exceeds the previous record total of 42 established at Shasta Dam.

LOCATION SKETCH

The new airport will be situated approximately midway between Scranton and Wilkes-Barre and will serve an area with a population of 629,000. Scranton alone has 140,000 inhabitants and is the third largest city in Pennsylvania. There is considerable winter fog in the section, but the airport site is high enough to minimize trouble from that source. It lies at Elevation 900, which is about 150 feet higher than Scranton and 260 feet higher than Wilkes-Barre.

IF WE needed any additional assurance that the age of aviation is here, it was provided by the vast and vital participation of aircraft in the war. Persons in every city, town, and hamlet of the nation, from adults down to small children, became familiar with military planes of every type through newspapers, magazines, radio, and motion pictures. Thousands of these people were employed in aircraft factories, while many of their sons and brothers in the services manned, worked on, or rode in planes. Thus a large segment of the population became definitely air-minded.

Last November, in a report to Congress on the need for a national airport plan, the Civil Aeronautics Administration (CAA) of the Department of Commerce, which is the principal Federal agency concerned with promoting civilian flying, estimated that as a by-product of the war, when all service men have returned to the country, we will have nearly 6,000,000 prospective flyers. This total is made up of 350,000 Army and Navy pilots, 150,000 civilian pilots and students, 2,500,000 men trained by the armed forces in other aviation skills, an almost equal number of aircraft-factory workers, and 250,000 high-school students that were enrolled in aeronautics courses each war year.

It was observed that if only one out of four of these takes up aviation as a vocation or avocation, there will be 1,500,000 airport users, while the others will be prospective airline passengers. In addition, there are thousands of persons outside of these specialized groups who are regular patrons of airlines or who are evidencing an interest in flying either for business or for pleasure. Now that priorities for air travel are no longer needed, and the major companies have announced fares that are in many instances competitive with first-class railroad rates, plus Pullman, we may expect a huge expansion in commercial flying.

The rate of growth of civilian aviation will depend largely upon how fast additional airport facilities are provided. There are now approximately 30,000 civilian aircraft in the United States, and the CAA estimates that they will number 400,000 ten years hence and continue to increase thereafter. On this assumption, the November, 1944, report recommends that 3050 airports be built and that 1625 of the existing 3000 be improved at an estimated cost of $1,250,000,000, with $230,000,000 going for land and buildings and for construction. It further suggests that the program be spread over a 5- to 10-year period, with the Federal Government and non-Federal public agencies sharing the cost on some proportional basis to be established by Congress. In this connection it points out that the 50-50 cost arrangement of the Federal-aid highway program has proved successful.

"The airport," the report states, "is the basic facility of aviation just as the highway is the basic facility of auto-

ONE OF THE SOURCES OF AIR SUPPLY

With more than 60 rock drills in operation, there is such a great demand for compressed air that portable compressors are grouped at three points and the air is piped from them to different sections of the working area. Two of these groups, one of which is shown at the right, were made up of Ingersoll-Rand oil-engine-driven units. Each of the eight machines pictured delivers 500 cfm. of air at 100 pounds pressure. All discharge into a common header, and their output is piped to the 66-inch by 18-foot receiver shown at the left. A 6-inch delivery line runs from the receiver to the working site, where branch distribution lines extend for 200 feet in opposite directions to serve the drills through hose take-offs. The streamlined front ends of six of these compressors are shown above.

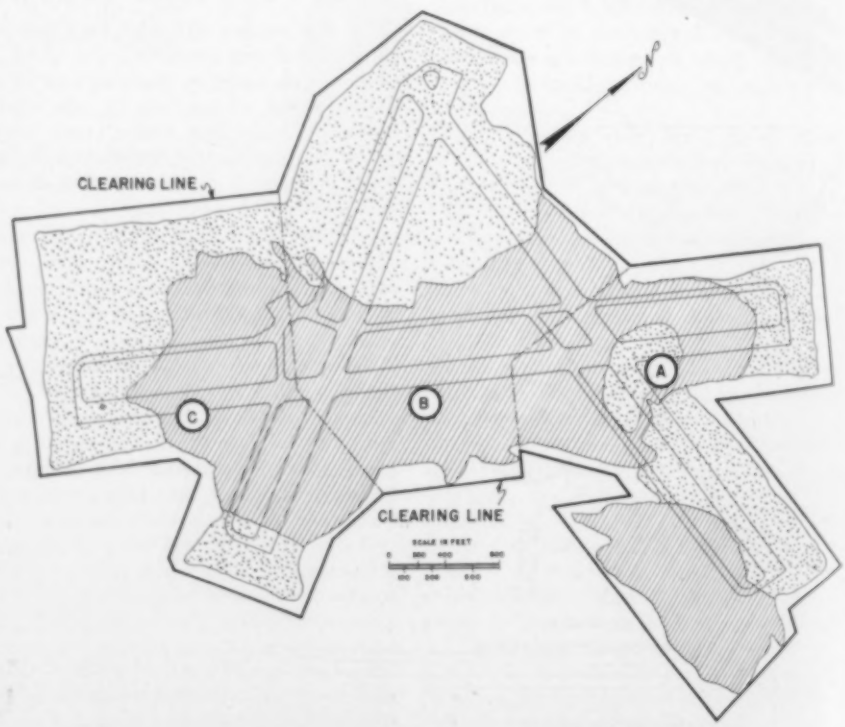
mobile transportation, or harbor facilities are basic to water transportation. By investing $25,000,000,000 in roads during the past 25 years, we have made it possible for the United States to become a nation on wheels—with 32,000,000 motor vehicles in operation in normal times. For a much smaller investment, we can start the United States on its way to becoming a nation on wings, with all that implies in war and peace."

Prior to the creation of the Civil Aeronautics Authority, airport construction was not on a well-organized basis. The larger cities and those that were located where they would obviously benefit by air service were naturally the first to become air-conscious. The first transcontinental flight was made between New York and San Francisco in 1920. Air-mail subsidies from the Government were of material aid in the growth of the pioneer lines, but the general public was slow to embrace air transportation and most cities had no real conception of what the future held in store for it.

In an effort to foster aviation, the Government formed the Bureau of Air Commerce in 1926 as a part of the Department of Commerce. It was charged with the licensing of pilots, making flying safer, promoting new navigational facilities, mapping the airways, and furnishing flight information. These were all essential services, but so far as the development of airports was concerned, the bureau could act only in an advisory capacity.

Then came the depression period in which airport construction was closely related to the relief problem. There was an awakening of interest among local governments, and any project with potentialities was eligible to receive Federal funds. However, the aim was to provide work for the largest possible number of persons, and most of the airport schemes brought forward were ruled out because they called for the use of too much power equipment and too few men.

In 1938 the Civil Aeronautics Authority was created by act of Congress, and in 1940 it was divided into two main departments: the Civil Aeronautics Ad-



DISTRIBUTION OF CUT AND FILL AREAS

A plan drawing of the airport site showing the positions of the future runways. The areas that are being excavated are indicated by crosshatching, and those where the material is being deposited in fills are stippled. The quantities in the two categories are expected to balance, but if additional fill material is needed it will be taken from a borrow area outside the clearing line at the lower left. The highest point on the site is at the lower right, where a hill rises to an elevation 110 feet higher than that of the finished field. To minimize the possibility of its obstructing planes alighting or taking off, that side of it adjacent to the runway is being cut back on a 1 to 7 slope. This sketch also shows the contractor's division of the area into three sections, each of which has its own organization, workers, and equipment.

ministration and the Civil Aeronautics Board. The first-named operates six principal agencies, among which is the Airports Service. The long-range function of the latter is twofold: first, to act as consultant for state and local groups in matters of airport and airport-building designs, management, and urban planning as it involves airports; and, second, to prepare a master plan for a national system of airports. This second phase of its activities has already been referred to in connection with the proposal submitted to Congress last year.

From the time the CAA was organized until the end of the war the program of airport construction was necessarily bound up closely with the problem of national defense. In the forepart of that period the relief angle also was in evidence. From 1940 to 1945 Congress appropriated $400,000,000 for CAA defense airport projects without specifying where the money was to be spent, but directed that the secretaries of the War, Navy, and Commerce departments must approve all sites. Of these, the Army was most vitally interested at the time, being concerned with the establishment of a string of airports along the Atlantic Coast and with supporting ones within a zone extending inland for approximately 100 miles. In all cases, however, the CAA Airports Service functioned as the over-all coördinator of plans and standards. It gave final approval to sites and to the plans for each airport with respect to grading, drainage, runway layout, taxiways, paving and lighting. During the 1941-44 period it authorized an expenditure of $400,000,000 for the building of airports, all the actual work to be done by private contractors as the CAA does not act as a construction agency.

One of the last projects that was on the CAA prewar program is now being executed at Avoca, Pa., between Scranton and Wilkes-Barre, the two principal cities in the anthracite-coal belt. It is officially designated as the Wilkes-Barre-Scranton Airport and represents the culmination of nearly twenty years of effort by the residents of that area to obtain adequate airport facilities. Both Scranton and Wilkes-Barre have a flying field, but neither is large enough to accommodate commercial air liners, so the region has been without direct transport service. Topographical conditions would not permit enlarging the Wilkes-Barre airport sufficiently to provide runways long enough for transport planes. These physical restrictions do not apply to the Scranton field; but as it is located approximately 20 miles from Wilkes-Barre, the citizens of that place did not favor its development. It was generally agreed that a site somewhere between the two cities should be selected, and when the CAA came into being, its interest in the problem was enlisted. The tract at Avoca that is now being developed was approved by the CAA and the other Federal agencies concerned and the undertaking was placed on the CAA schedule.

REMOVING A JACKBIT

The use of Jackbits for both wagon drills and Jackhamers reduces the quantity of drill steel that must be handled and also results in other advantages.

DRILLING TOE HOLES

Most of the primary drilling is done by putting down vertical wagon-drill holes back of the working face. In some places where the face is high, supplementary horizontal lifter holes are put in at the base or toe. These have lengths up to 30 feet. The adaptability of the FM-2 wagon drills is such that they can be used either for vertical or horizontal drilling. These pictures show the drilling of toe holes as viewed from the top of the working face and from the drilling level.

BLASTING AND LOADING

At the right is shown a powder crew loading wagon-drill holes with gelatine dynamite in 2x12-inch cartridges. For loading blasted material into trucks there are sixteen power shovels, four of which are 5-yard electrically operated units like that pictured above. In an average day each of the latter will fill some 350 trucks carrying 12 or more cubic yards each. One shovel set a mark by handling 420 loads in a 10-hour shift.

Under the legislative set-up of the CAA at that time, airport sponsors acquired the land, while the CAA supplied the funds for construction work other than buildings. The sponsoring body agreed to maintain and operate the airport, to make its facilities available to the public without discrimination, to prevent its approaches from becoming obstructed, and to lease it to the Government during times of national emergency for a nominal consideration. The joint movement by Wilkes-Barre and Scranton was carried on through their respective chambers of commerce, and as two counties were concerned, the necessary legal authority to proceed with the plan was obtained from the Pennsylvania legislature. Under the power thus bestowed, the land needed for the site was condemned. Wilkes-Barre and Scranton are 22 miles apart, and the site is at the approximate midpoint. Within the section the airport will serve there is a population of 629,000, constituting the nineteenth largest metropolitan area in the country.

At the time the project was being worked out we were on our way into the war, and it became of interest to the War Department because of its strategic location with respect to the coast and to the cities of New York and Philadelphia. The Corps of Engineers of the Army therefore made detailed surveys of the site and called for construction bids. An acceptable tender was received, and there was every indication that the work would proceed. But on the day in May, 1942, when the contractor was to sign the agreement, the Army decided that both his organization and the equipment he would employ were needed more elsewhere. The undertaking was held in abeyance and the sponsoring body allowed its options on the property to lapse, but the CAA retained the project on its schedule. Last spring it was revived and steps were taken to commence operations as soon as possible.

Bids for clearing and grading the site and putting in drainage structures and conduits for lighting circuits were opened on July 6, 1945. The contract was awarded on July 12 to George M. Brewster & Son, Inc., on its low bid of $3,348,882, which was only $534 below the figure submitted by the next-lowest bidder, Hunkin-Conkey Construction Company. Because it is desired to complete the airport before the winter of 1946 and the current work must be followed by paving, lighting, and other finishing operations, the Brewster firm was given only 300 calendar days to carry out its contract and is subject to a penalty of $3500 for each day it exceeds that time limit. Moreover, it is known that the work will have to be shut down for a period of several weeks, at least, when severe freezing weather makes it impossible effectively to excavate the moist ground.

In view of these circumstances, the contractor lost no time in getting work underway. Although allowed until the first of August to start operations, the Brewster forces were in action on July 16, only four days after the contract was signed. Since then, the pace has been steadily accelerated and a quantity of equipment assembled and put in service such as has seldom before been employed on a job of this size. A progress schedule was prepared as a guide for the work so as to make sure of finishing it within the allotted time, and according to it 70 percent of the clearing and grubbing was to be completed by October 1. Actually, 86 percent was accomplished by that date, and the remainder was being done by a logging contractor to whom it had been turned over under an agreement to pay Brewster for the merchantable timber recovered.

On the same day—October 1— 29 percent of the excavating was reported done, although the program called for only 18 percent. The scheduled movement was 26,000 cubic yards a day, but the Brewster forces set themselves to reach a daily quota of 50,000 cubic yards before winter enforced a suspension of work. By October 1 they were handling 40,000 cubic yards, and by the end of that month they had hit 45,000 cubic yards. While the duration of the winter interruption cannot be foretold, the expectations are that the time allowance for completion of the contract will expire next August. Progress made thus far, however, indicates that the job will be finished some time in May.

The airport site is an irregularly shaped plot on which three crisscrossing runways, having respective lengths of 3700, 4500, and 5200 feet, will be disposed as an accompanying drawing shows. Its area within the clearing lines is 350 acres of which approximately 278 are being graded. Roughly, 152 acres are in cut areas and 126 in fill areas, or about 60 to 40 percent, respectively. Cuts range up to 38 feet deep, and fills to 45 feet. The quantity of excavated material to be handled is around 4,000,-

000 cubic yards. It is unclassified, but is estimated to run from 60 to 90 percent rock.

Topographically, the site presented the general aspect of a knoll with the greatest elevation in the center and sloping downward in all directions. The central section therefore constituted the principal cut area, although the highest ground was adjacent to one end of one of the runways. While the terrain could not be termed rugged, it was very uneven, little of it was flat. Virtually the entire site was covered with rather dense vegetation, ranging from shrubs and scrub growth to trees large enough to produce saw logs. There was practically no topsoil, and in most places rock was at or close to the surface. The rock is all of sedimentary origin and varies from soft shale to hard sandstone, with occasional layers of Pottsville conglomerate containing pebbles that are troublesome to the drillers.

Offices, shops, and supply depots were established just beyond the northern boundary of the site, and the general scheme of excavating was to start there and work progressively toward the opposite side, keeping the working faces in a generally straight line. As was previously mentioned, the job is outstanding for the great amount of power equipment assembled to speed up progress, and much of this machinery is new and of the most modern types obtainable. The number of wagon drills in service is believed to be the greatest ever concentrated in one working area. There are 46 Ingersoll-Rand X-71 drifter drills mounted on FM-2 carriages. The previous high mark was established at Shasta Dam, Calif., where 42 such drills were used. Equally imposing is the list of other major equipment. There are sixteen power shovels, all of Bucyrus-Erie make. Four of them are electric machines of 5-yard capacity and the others are diesel-engine units—ten of 2½-yard and two of 2-yard size. For moving the excavated materials to fill areas there are 69 twelve-yard Euclid trucks of which 34 are of the bottom-dump and 35 of the end-dump type, thirteen LeTourneau Carryalls, three LaPlant-Choate Carrimors, and five Super C Tournapulls. Twenty-three heavy, diesel Caterpillar bulldozers and tractors are in service. In addition, there are between 40 and 50 pieces of miscellaneous equipment.

To facilitate operations, the working area has been divided into three substantially equal parts, with an area superintendent and a rock superintendent in each section. Each subdivision has its complement of equipment, which is varied to meet changing conditions as they arise. Each also has its own supply of compressed air piped from batteries of portable compressors stationed outside of the working area. Two of these groups each contain eight 500-cfm. units and the third has five 700-cfm. machines. Their aggregate capacity of 11,500 cfm. compares favorably with that of the air-producing plants in many large industrial establishments. Besides these fixed sources of supply, there are three smaller portable compressors that are moved about the job to furnish air for special services or at locations where it is not convenient to run hose lines from the distribution systems of the main plants.

Most of the primary drilling is done by putting down vertical holes with the wagon drills. These extend to a maximum depth of 20 feet, and their spacing varies from 4x4 to 10x10 feet, depending upon the nature of the rock and the depth of the holes. In some places where deep cuts are being made, wide-spaced vertical holes are supplemented by horizontal lifter holes at the toe of the working face. Holes are started with diameters of from 2½ to 3½ inches, according to their depth, and are bottomed at from 1½ to 3 inches. Jackbits are used for all drilling and are reconditioned by the Howells Mining Drill Company at its service station at Plymouth, Pa.

Blasting of the wagon-drill holes is done with gelatine dynamite in cart-

EXPLORATORY DRILLING

The existence of extensive coal-mine workings underneath the site necessitates special steps to guard against future subsidence of the surface. Exploratory holes are drilled at stipulated intervals (usually on 50-foot centers) to a depth of 20 feet below subgrade. Where an opening is revealed, the overburden is removed and the area is then compactly backfilled. This picture shows a drill working in a section that has been excavated down to grade. In the foreground is what remains of a slope that formerly gave access to mine workings below. A test hole is being put down preparatory to bulkheading the opening with concrete at a depth of 20 feet and then backfilling it. The drill is one of those used for blastholing, but its tower has been heightened so that it will accommodate 10-foot changes of steel. Mounted on the truck in the background is a 210-cfm. Mobil-Air compressor that supplies air for the operation.

JACKHAMERS AT WORK

Supplementing the 46 wagon drills are eighteen Ingersoll-Rand Jackhamers, three of which are pictured above. They are drilling shallow blast holes to take up bottom in an area that remained slightly above grade after initial excavating.

SERVICE EQUIPMENT

To insure the proper functioning of the 150-odd pieces of power-driven equipment, the contractor maintains an efficient service department. Major repairs are handled in shops that provide complete facilities for the purpose, but minor ones are made in the field by mechanics who utilize a special truck fitted out with the necessary tools and carrying a supply of small parts for the various machines. A tire-repair and battery-service crew likewise responds to calls in the truck shown at the top-left. Mounted on it are a 3-hp. Type 30 compressor that supplies air for tire inflation, a gasoline-engine-driven generator set that furnishes current for the truck's floodlights, and a chain hoist on an overhead rail for handling heavy tires when making changes. All power-driven equipment is lubricated and refueled every night by a force of twenty men that employs four grease trucks and three tank trucks. Two of each of these types are shown just above, with the lubrication building at the left. At the upper right is an inside view of one of the grease trucks. Arranged along the left side are six reels of hose that deliver grease from the row of steel drums on the right. Compressed air for this service comes from a tank-mounted Type 30 compressor in the front of the truck, where there is also a generator set for floodlight operation.

ridges from 1½ to 2½ inches in diameter, 60 percent strength being put at the bottom and 40 percent elsewhere. The amount of explosive loaded varies with the character of the ground, spacing of the holes, and other conditions. Firing is done by means of electric detonators with from 1 to 10 delays and by 5-kw. generators. As many as 750 holes have been shot at a time.

The aim is to control drilling and blasting so that all material will be reduced to sizes that can be loaded by the shovels. Occasional boulders that have to be broken up are drilled with Jackhamers for secondary blasting. The latter machines are also used for the primary drilling of small outcroppings of rock outside of the main drilling areas. There are eighteen of them in service: twelve JB-5's and six S-68's.

Blasted material is loaded by power shovels, hauled to fill areas, dumped, leveled with bulldozers, and compacted with sheep's-foot rollers in lifts or layers ranging up to but not exceeding 4 feet. When the material is dry enough to require the addition of moisture for adequate consolidation, water is supplied by a 4600-gallon tank truck pulled by a Euclid tractor. Although the plan on which the job is being developed insures the trucks a flat surface, well-defined roads are prepared for their use and are regularly maintained. Six Caterpillar road patrols are provided for the purpose; and when dry weather causes dust, the haulageways are sprinkled with water. During the summer work period some of them were even oiled. These steps not only promote fast haulage (speeds of 30-35 miles per hour are usual) but also reduce truck maintenance and repair costs. It has been computed that truck travel on the job will aggregate 191,880 miles, and for half that distance, or 95,940 miles, the vehicles will be loaded.

Careful attention is given all equipment to keep it in efficient working order. All units in each of the three working areas are corralled at the close of each day's shift for lubricating and refueling. A special force of twenty men in charge of E. H. Looschen spends ten hours each night in this service. Four grease trucks, three fuel trucks, and a tire-and-battery truck are employed. In an average month, the power-driven machines consume between 80,000 and 100,000 gallons of diesel oil, 6000 to 10,000 gallons of gasoline, 10,000 quarts of lubricating oils, and 6000 to 8000 pounds of grease. All rock drills are lubricated by air-line oilers. Shops are maintained for making major repairs of equipment, but minor ones are attended to without bringing them in. The mechanics use a special service truck fitted out with all the tools required and also carrying small spare parts for the various types of machinery on the job.

The construction site is underlain by five veins of coal at various horizons between the surface and a depth of 300 feet. Extensive mining operations have been carried on there in the past, and the specifications provide that the contractor shall excavate down to any underground openings extending to within 20 feet of the subbase of cuts and fills and then compactly backfill the areas so as to prevent future subsidence. Some of the shallower workings have wholly or partially caved in, and the problem is

further complicated because "bootleg" or illicit mining was rather prevalent during the depression years and the locations and extent of the resultant openings cannot be determined from the maps made available by the legitimate coal companies. Exploratory drilling to a depth of 20 feet below the subbase is consequently required. Holes are usually spaced on 50-foot centers, but are spotted closer together wherever unmapped openings are revealed in order to trace their course in greater detail.

In locations that were to receive fill, the exploratory drilling was of necessity done before any material was placed; in cut areas, it will naturally have to wait until excavating is completed. The same wagon drills that are doing the blastholing are employed in the exploratory work, but for this purpose the contractor devised a tower extension to permit making 10-foot changes of steel instead of the usual 6-foot changes. The holes are smaller in diameter than the blast holes and are put down by Jackbits that have been used for blastholing and been reduced in size by several resharpenings.

IN CHARGE OF THE WORK

Project Manager R. W. Moore and four of his key men. Left to right: William A. Foley, equipment superintendent; Harold A. Deitler, resident engineer; Lewis Frankenfield, general superintendent; Mr. Moore; and Thomas P. Gatens, office manager.

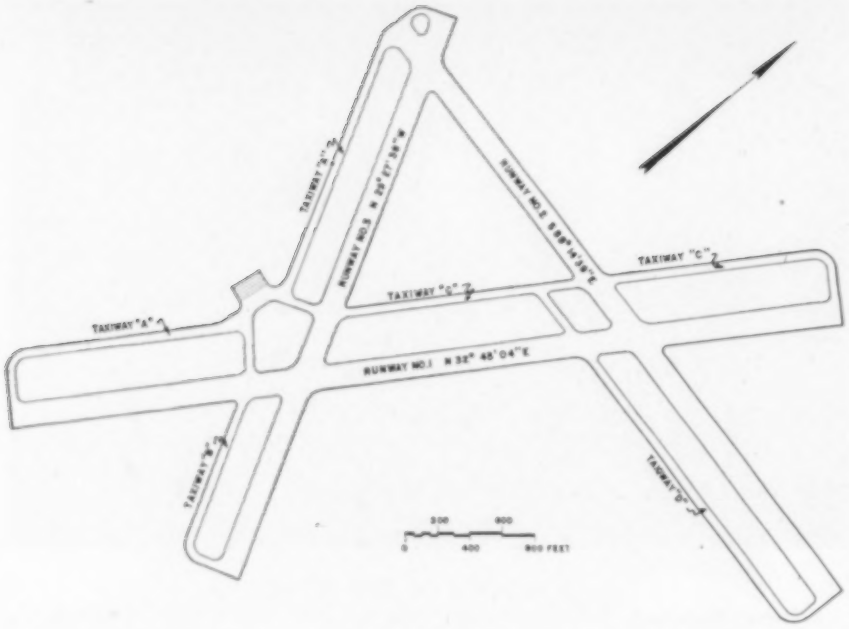
When the work was started, there were twelve mine shafts in the area. All equipment such as hoists, rails, etc., in them or on the surface was removed by the contractor. The shafts were then bulkheaded with reinforced concrete at a depth of 20 feet below subgrade, and backfill was placed and consolidated. In addition, there were some excavations from former open-pit operations. These ranged up to 30 feet in depth and all were filled in and compacted to subgrade. Although the lack of complete information on the scope of the clandestine mining makes it impossible to estimate accurately the quantity of coal still remaining in the ground that is being cut away, it is expected that as much as 50,000 cubic yards of it may be unearthed. This becomes the property of the sponsoring agency, and the contractor is required to separate and to stockpile it in designated storage areas.

To provide for adequate drainage of the field, the contractor will lay 70,000 linear feet of tile and concrete pipe ranging from 6 to 42 inches in diameter. Conduits for the electric-lighting system will consist of 38,000 linear feet of 2- and 3-inch lines.

A separate contract will be let for the paving of the runways, taxiways, parking area, etc., which will be done after the conclusion of the current work and will involve the surfacing of 303,000 square yards. The maximum thickness will be 8 inches on runways and 9 inches on taxiways. The type of pavement to be used has not been determined, but

PLACING FILL

Upper right– As the bottom gates of a moving Euclid trailer truck are opened, 20 tons of broken rock are added to the thousands that have been deposited previously. Above– A bulldozer levels off the windrow of stones. Right– A Tournapull arrives with a load of dirt and strews it over the surface. Afterward the bulldozer will spread it evenly to fill the voids between the rocks. Repeated passage of these heavy machines consolidates the fill, but it will be further compacted with sheep's-foot rollers.



PAVING PLAN

Under the size standards set up by the Civilian Aeronautics Administration there are five classes of airports. This one falls in Class 4, being designed to handle the largest commercial aircraft now in service and those planned for the immediate future. The three runways will permit 90 percent of the take-offs and landings to be made within 22½ degrees of the true direction of winds of 4 miles per hour and over, based on weather-bureau records. Runways Nos. 1, 2, and 3 will have respective lengths of 5200, 4500, and 3700 feet. Runways will be 150 feet wide and taxiways 50 feet.

CAA engineers state that the existence of voids underneath the field favors a flexible surfacing, except for parking lots where concrete may be used. All sections of the area that have been disturbed by grading and that are not paved will be seeded. While the cost of the work on this subsequent contract can only be estimated, it is expected that the completed airport will represent a total expenditure of around $4,200,000.

The new airport will definitely place the Scranton-Wilkes-Barre region on the aerial map of the nation. Arrangements have already been concluded with two air-transport companies to make it a scheduled stop on some of their runs. American Airlines has been granted a franchise for east-west traffic and Colonial Airlines one for north-south traffic. Applications from other lines are yet to be acted upon. No plans have thus far been made by the sponsoring body for the erection of buildings. In addition to being the "anthracite capital" of America, Scranton is an important industrial community, and so is Wilkes-Barre. Scranton has the largest Nottingham lace mill in the country and also the leading correspondence school. By rail, Scranton and Wilkes-Barre are approximately four hours from New York City; by air, the distance between them can be covered in about one hour.

The undertaking that has been described is in Region 1 of the Civil Aeronautics Administration, which has offices in New York City. R. M. Brown is chief airways engineer and James H. Herendeen is resident engineer on the job.

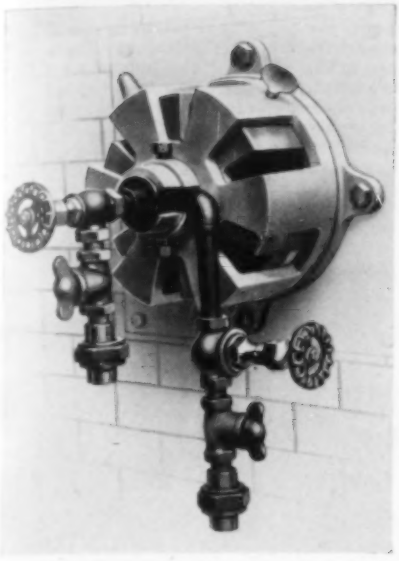
The firm of George M. Brewster & Son, Inc., was organized in 1894. Its first large contract was the construction of the $3,000,000 Camp Merritt in New Jersey in 1917. It did all the work on the New Jersey plaza of the George Washington Bridge across the Hudson River, including approaches and various feeder highways, at a total cost of $12,000,000. A similar job was the building of the New Jersey approaches to the Lincoln Tunnel, aggregating $9,000,000 worth of work. It has also constructed other highways and viaducts in New Jersey's road system for approximately $7,000,000. For the New York Board of Water Supply it built the Merriman ($6,000,000) and the Neversink dams ($3,500,000). Among other dams to its credit are the Mohawk in Ohio ($2,000,000) and the Crooked Creek in Pennsylvania ($3,000,000). During World War II it carried out for the Government and private firms construction projects representing expenditures of millions of dollars and including Army and Navy storage depots. It is rated as one of the nation's largest independent contracting companies. Its founder and long-time chief executive, George M. Brewster, died in 1930. His son, William J. Brewster, is now president. Other officers are W. W. Blauvelt, vice-president and chief engineer; E. C. Grey, secretary; and Richard D. Sawyer, treasurer. Headquarters are at Bogota, N. J.

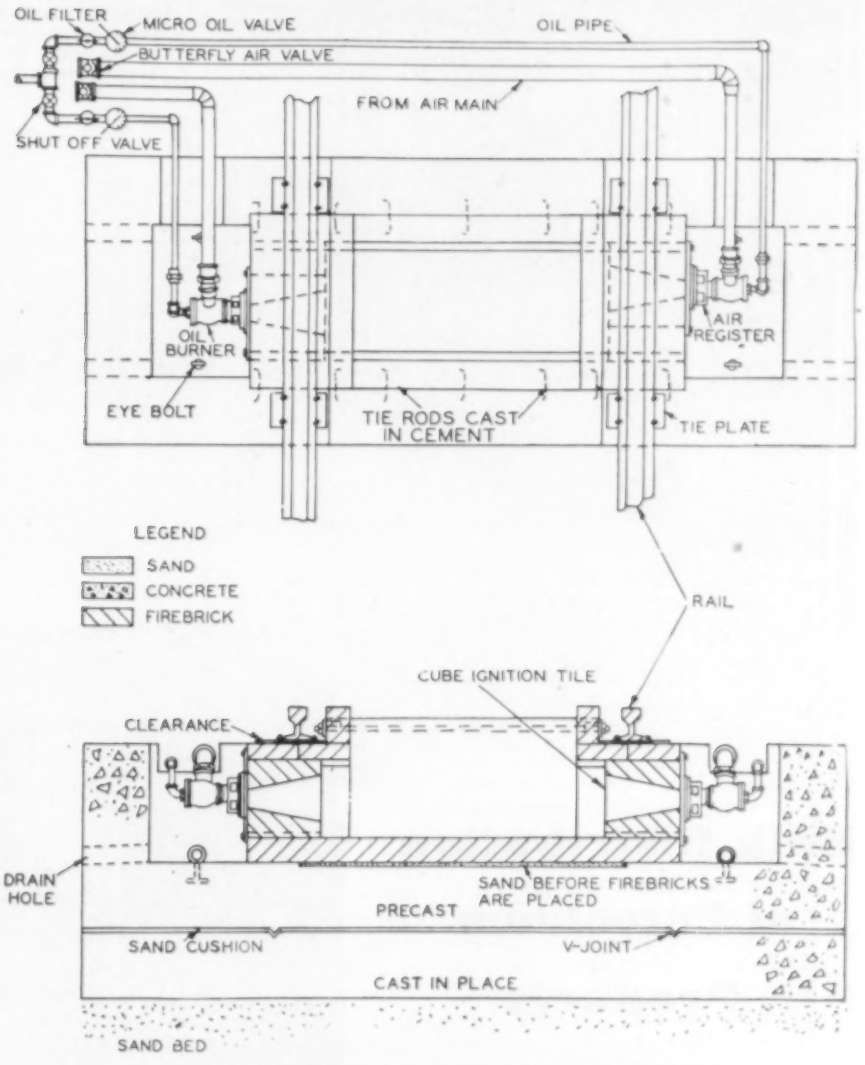
On the present contract, the Brewster organization is headed by R. W. Moore, project manager. Lewis Frankenfield is general superintendent, H. A. Deitler is resident engineer, and T. P. Gatens is office manager. Work is carried on in one 10-hour shift six days a week. Approximately 600 men are employed, and the weekly payroll comes to something like $40,000.

JOB SUPERINTENDENTS

These five men are responsible for drilling, blasting, excavating, moving, and placing rock and dirt at the rate of more than 40,000 cubic yards a day. Left to right: O. Teijeiro, area superintendent excavating and moving; Richard Dolmetsch, area superintendent excavating and moving; Lewis Frankenfield, general superintendent; James Shockley, area superintendent drilling and blasting; and Frank Itro, area superintendent excavating and moving.

Frozen Coal Thawed by Radiant Heat





PIT CONSTRUCTION AND PIPING DETAILS

The drawings show an oil-burning installation with Hauck Venturi low-pressure burners mounted in the small combustion chambers. The arrangement is the same with high-pressure oil burners, one of which is pictured at the left, except that the latter use compressed instead of blower air to supply oxygen for and to intensify combustion. As soon as a coal car has been thawed out it is moved on for dumping and another takes its place. When not in use, the pits are covered with metal plates.

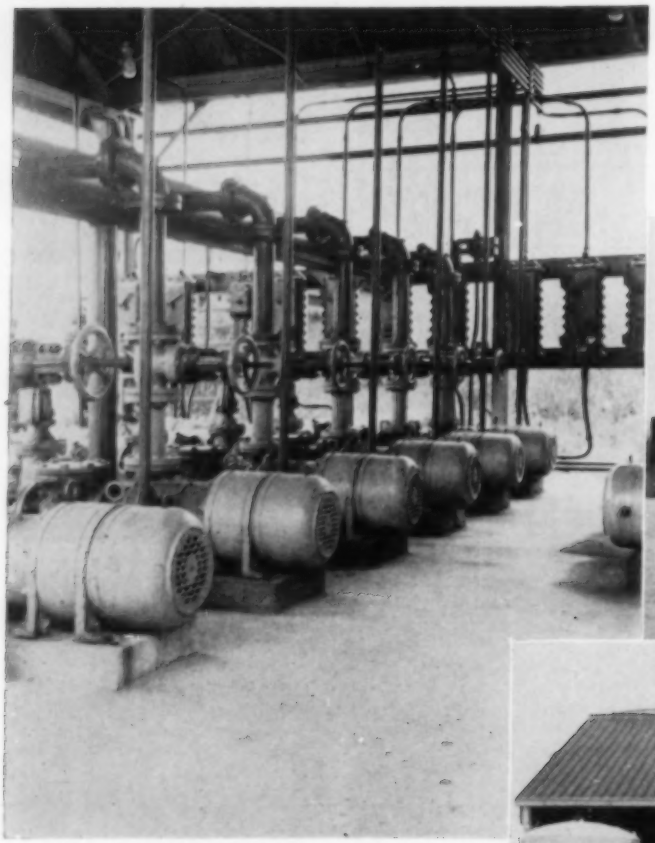
BULK coal shipments in hopper cars present no unloading problem in warm weather. But it's a different matter when winter sets in. Then there are tie-ups in yards or at discharge points because the fuel is a frozen mass and will not flow until thawed in some manner, possibly with steam or with heat applied by blow torches. Neither is satisfactory because of the time element involved, and in the case of blow torches the flame is apt to cause damage because it must be brought in direct contact with the hoppers if it is to do any good.

These handicaps are overcome, we are told, by thawing pits that have been especially designed for the purpose by the Hauck Manufacturing Company. These pits are built between the track rails and are so spaced that when a 2-pocket car, for example, is run over them they will be right under the hoppers. The new system does its work with radiant heat, which is produced by two burners mounted in small combustion chambers and firing toward each other from the ends of the refractory-lined pit.

Different types of burners are used, depending upon whether oil or low- or high-pressure gas is the fuel and whether compressed air is available in sufficient volume and pressure. When fired with oil, Hauck Venturi high-pressure burners may be utilized provided each pit can be supplied with a maximum of 50 cubic feet of air per minute at 60 pounds pressure. When a yard is not piped for air, or the volume is inadequate, low-pressure units are installed, together with a motor-driven blower and an oil pump. The latter equipment varies in size to serve a battery of burners or a number of pits. In the case of gas burners, they are furnished with air-type mixing tees or with gas-air inspirators for low- and high-pressure gas, respectively.

The heat generated by the flaming jets is intense and affects every part of the hopper area without direct flame contact. Thawing of the coal is effected relatively quickly, but depends, of course, upon the temperature of the atmosphere. It is said to take not more than half an hour to dump a load under the worst of freeze-ups, whereas a 2-hopper car can discharge in normal winter weather fifteen minutes after the burners are ignited. Near Rochester, N. Y., where it is not unusual for the thermometer to register around zero during the cold season, the New York Central Railroad has a coaling station which is equipped with twelve thawing pits. According to that road, 4301 trains stopped there to take on coal during March of 1944 without being delayed by frozen hoppers.

Fuel consumption also varies with the severity of the weather and the size of the car, averaging from 9 to 12 gallons of oil, or the equivalent heat in gas, at a cost of $1 or less per car. One big colliery reports that it thawed 116 cars of coal with 900 gallons of oil, or only 7.8 gallons per car. In addition to doing the work with a considerable saving in time and labor, the manufacturer claims other advantages for the system. Coal thawed by radiant heating contains much less moisture than it would ordinarily. This is desirable when the fuel is to be pulverized or loaded into hoppers feeding locomotives. In the case of coal for the retail trade, it eliminates the use of chloride which not only messes up cellars but ruins shoes, floors, rugs, etc.



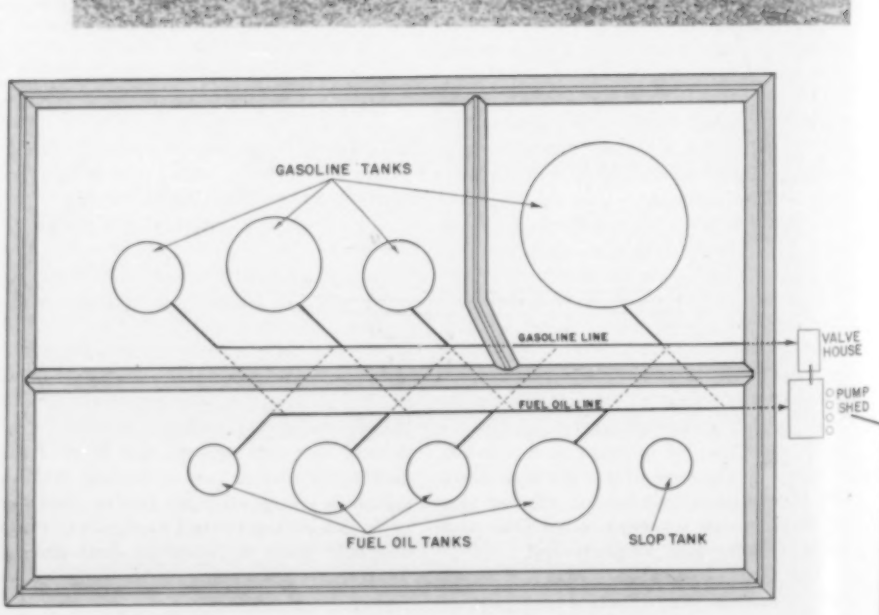
PUMPS AND PRESSURE TANKS

At the left are a number of the centrifugal pumps in one of the four groups that supply fuel to the loading racks. There are 22 identical pumps in this service. The bottom view shows the four pressure tanks, with the pump shed behind them. Immediately below are pictured some of the nine storage tanks, with the pressure tanks, pump shed, and valve house in the foreground.

Bulk Distribution of Petroleum Products

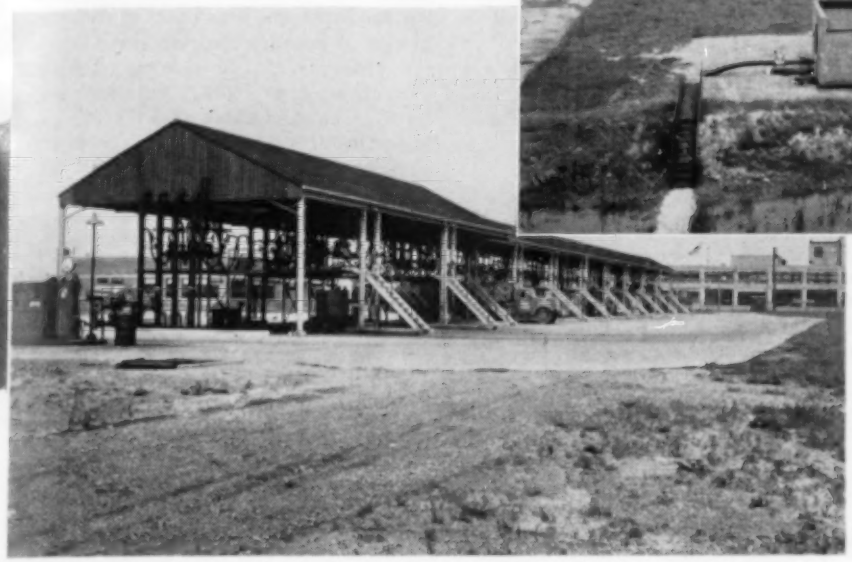
W. J. Kearns

IF YOU run a car—and about 25 million Americans still do—you drive into a service station confident of getting gasoline and lubricating oil. And if you burn fuel oil in your household heating plant you need only make a telephone call to have a supply of it delivered to you. It is true that during the wartime period one had to observe such amenities as giving up ration stamps, but those were matters of government edict and not the doings of the oil companies. For it is the business of the oil industry to sell its products, and everyone must concede that in normal times it purveys them with a minimum of inconvenience and delay. Motorists even get extra gratuitous service in the form of a windshield wipe, water and battery check, and a few puffs of compressed air in their tires.



GENERAL VIEW AND LOADING RACKS

The picture at the right was taken from the top of one of the storage tanks. The valve house is in the middle foreground and the pump shed on the right. Beyond them are the office and the loading racks. The DeSoto automobile plant of Chrysler Corporation is in the background. The view below shows the loading racks, which can accommodate eighteen standard fuel trucks and four transport trailers simultaneously.



These things have grown to be so routine that few of us probably ever give much thought to how our gasoline and oil, which may be derived from petroleum produced a thousand or more miles away, are brought right to our doorsteps, so to speak, and at prices that have steadily declined through the years but reversed the prevailing trend during the early part of the war and thereafter remained stationary. They have come about, of course, through the smooth functioning of the highly ramified and expertly organized oil industry. The mechanics of the chain of operations that links the wells with the retail outlets for finished products in every section of the nation constitute one of the marvels of modern business. It is a powerful argument for maintaining the free-enterprise system that has built America.

The petroleum industry is essentially a chemical enterprise. It starts with a raw material that has limited uses and transforms it into a great variety of products for which there is a large demand. In our most recent prewar year, 1941, the breakdown of principal products sold to the public in the United States was: gasoline, 28,000 million gallons; fuel oils, 23,400 million gallons; kerosene, 2900 million gallons; lubricants, 1300 million gallons; road oils, 380 million gallons; miscellaneous, 500 million gallons; coke, 1.6 million tons; asphalt, 6.5 million tons; wax, 530 million pounds. Aside from these there were countless chemical, medicinal, and special materials.

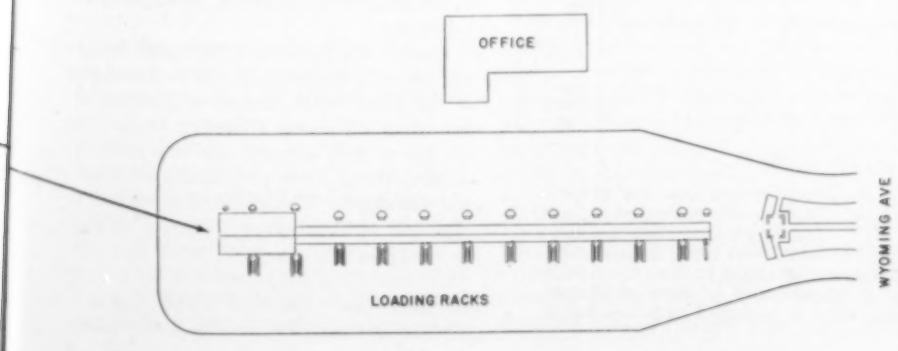
Excepting agriculture, the petroleum industry, with a capital investment of more than $14,000,000,000, is the largest enterprise in the nation. Directly and indirectly, it employs more than a million workers. No other country has crude-oil deposits equal to ours, and none approaches us in the consumption of petroleum products. We have 75 percent of the world's passenger cars. Prior to the war, one out of every five Americans had an automobile, a fact made possible partly because motor fuel sells at a cost within the reach of all. In 50 representative United States cities the retail price of gasoline, exclusive of taxes, was 13.3 cents a gallon in 1939.

The petroleum industry is composed of four branches: production, transportation, refining, and marketing, and all are closely correlated. Revolutionary changes and improvements have been made in all these departments since the business was launched and have been especially pronounced during the era of heavy automotive traffic. Since Drake's shallow discovery well was drilled in 1859, bits have probed deeper and deeper, and now a considerable proportion of our crude oil comes from 8000 or more feet below the surface. Wagons and river flatboats satisfied the transportation needs in the beginning, compared with our present elaborate system of tankships, tank cars, tank trucks, and pipe lines.

The first tank car consisted of three wooden tanks on a flat car and was put in service in 1865 or 1866. The pioneer pipe line, conceived by L. Hutchinson, was laid in 1862 to run oil from a producing farm to a railroad terminal. In 1865, Samuel Vare Sickle built a 4-mile line near Titusville, Pa., and precipitated a controversy with the teamsters, who

GENERAL LAYOUT OF PLANT

The nine storage tanks have a capacity of 7,500,000 gallons and are supplied by pipe-line deliveries from Socony-Vacuum's refinery at Trenton, Mich. The shaded strips in the tank area represent earthen dikes to impound the fuel in case of tank leakage or failure.



saw their means of livelihood endangered. In the following year troops had to be called out to protect oil-field property. The first line extending to the eastern seaboard was constructed in 1879 by the appropriately named Tide Water Oil Company. The industry entered the war with 130,000 miles of gathering and trunk lines, and notable additions were subsequently made to increase transportation to the Atlantic Coast to offset losses of tankers through German submarine attacks.

The marketing branch of the industry is a marvelously efficient system that is the outgrowth of severe competition among the various oil companies. In every section of the country it involves a complex interrelated network of transportation facilities, warehouses, and wholesale and retail outlets. As of 1940, there were approximately 240,000 service stations, plus 185,000 other retail outlets such as country grocery stores, with 1,350,000 gasoline pumps.

These stations receive their supplies of gasoline, lubricating oil, greases, etc., from wholesale outlets, many of which are owned and operated by the major oil companies. Prior to the war there were more than 30,000 of these establishments, including bulk plants and terminals, and they did an annual business of around $3,800,000,000. In the distribution of their products to retailers they utilized some 144,000 motor tank trucks, trailers, tractors, etc., that cost $375,000,000. They employed 75,000 persons and had an annual payroll of $156,000,000.

These bulk plants are of many sizes and types, but they can be grouped in three general classes:

1– Terminal bulk plants, which are the largest. They are usually located near refineries, at seaports where they can be served by tankships, or on pipe lines.

2– Division bulk plants, which are of medium size and are usually operated by major oil companies for the distribution of petroleum products to their own and independent retail outlets and to individual large-scale consumers who are supplied direct.

3– Local bulk plants such as are found in every town and small city.

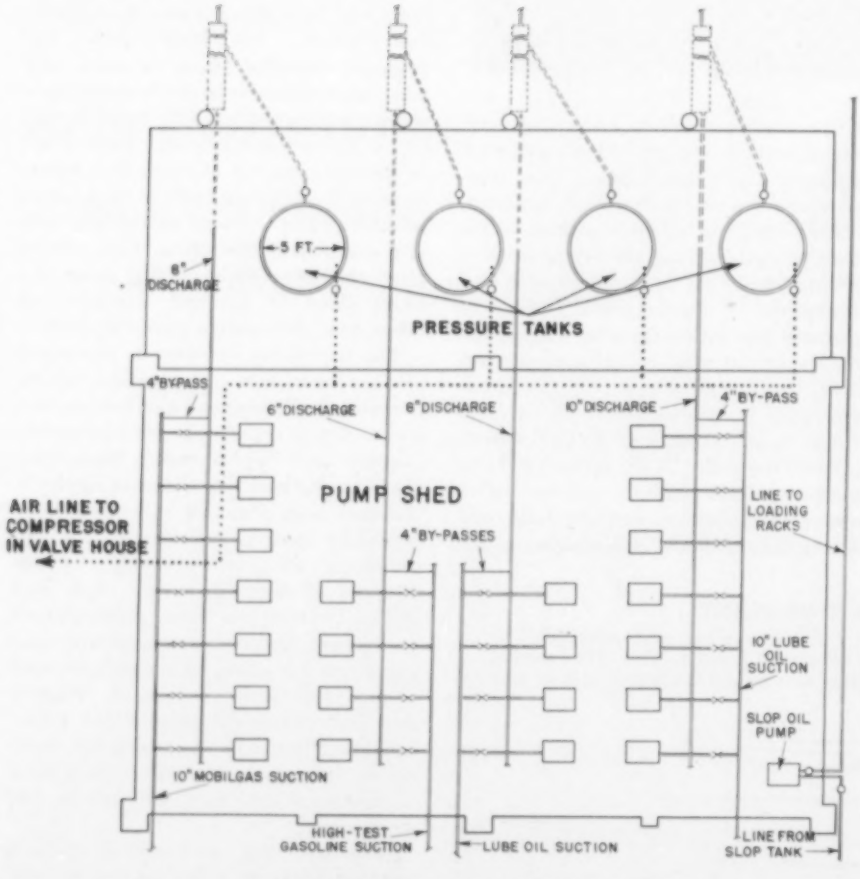
The refinery delivers gasoline and fuel oil to these bulk stations by tank car, truck, barge, or pipe line. They are run into storage tanks which range in capacity from 5000 barrels on up, the storage facilities providing from a two to a fifteen days' supply, depending upon local conditions. Lubricating oil is generally shipped in 50-gallon barrels, although much of it is now put up in quart or gallon cans. Tank trucks of varying sizes make deliveries from the bulk plant to service stations or consumers. To facilitate the handling of different grades of gasoline and oil, these trucks are often divided into compartments. For example, a 1600-gallon tank may have six subdivisions: three of 200 gallons, two of 300 gallons, and one of 400 gallons.

One of the largest and most modern bulk plants in the country was recently put in operation at Dearborn, Mich., by the White Star Division of the Socony-Vacuum Oil Company, Inc. This establishment serves the entire Detroit industrial area with two grades of gasoline and three grades of fuel oil. From it, company-owned and independent tank trucks haul several hundred thousand gallons of these products daily to retail outlets and large consumers.

The plant occupies a 600x1250-foot area on an 18-acre tract that was formerly an airport, and gasoline and fuel oil reach it through an 18-mile, 8-inch pipe line extending from the company's refinery at Trenton, Mich. They are pumped by two Ingersoll-Rand 4-stage centrifugal pumps having a combined capacity of 72,000 gallons per hour. Each unit is driven by a 150-hp. motor and operates at 3500 rpm.

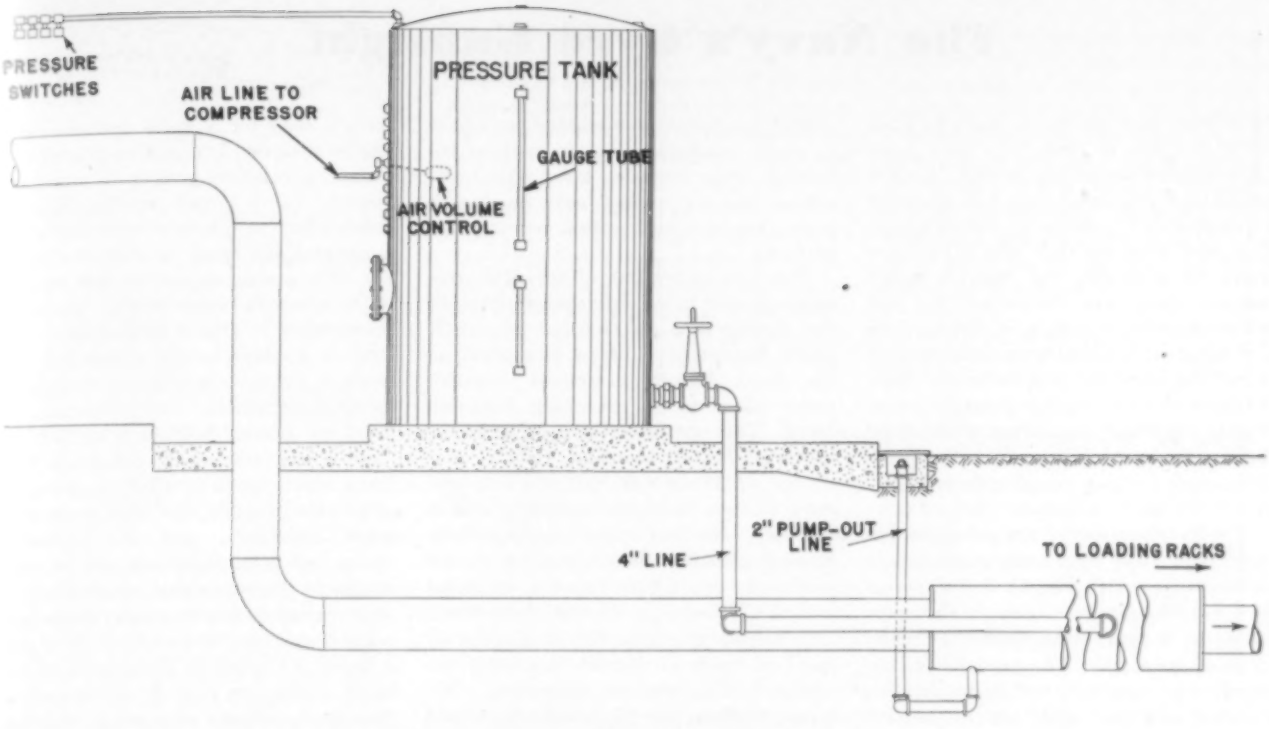
Prior to the construction of the new bulk plant and pipe line, all the fuel supplied by the company to the Detroit area had to be trucked from the refinery. Under wartime conditions, an acute shortage in both men and motorized equipment developed in this critical manufacturing district, making it more and more difficult as time went on to maintain deliveries. The completion of the new facilities solved these and other problems and enabled Socony-Vacuum to give its customers better service—to meet the increasing demands for its products especially during the latter part of the conflict when the many war plants in the area were operating on accelerated schedules.

One of the features of the pipe line is the use of a mechanical device known as a "go-devil" that makes it possible alternately to pump different types and grades of fuel through the line without mixing them, thus practically eliminating sloppage. The go-devil is placed in the line at the refinery when a change is made in the product being pumped, and the bulk plant is notified. It travels through the pipe and keeps the two liquids separate. At the bulk plant,



FLOOR PLAN OF PUMP SHED

General layout of the pump installation and of the four pressure tanks that control its operation. There are 22 Ingersoll-Rand 7½-hp. Motorpumps arranged in four banks, each of which handles a different product. The pump-shed floor is a concrete slab 6 inches thick and measuring approximately 25x41 feet. Ample space is provided between adjacent pumps to give convenient access to them for servicing, and room is available for setting up six additional units in the event future conditions call for plant expansion. The pump shed is protected by a roof but is open to the air on all sides.



DETAILS OF PRESSURE-TANK PIPING

Four delivery lines, under fluid pressure, extend from the pumps to the loading racks for handling different types of fuel. Downstream from the pump shed each line is connected with a pressure tank containing liquid and, above it, compressed air. When a truck at the loading racks starts drawing fuel from a line, the line pressure drops, and this drop is transmitted to the appropriate pressure tank. A decrease in tank pressure of 1½ pounds causes a float to operate a pressure switch which, in turn, actuates a magnetic switch that starts one of the pumps. The opening of additional valves at the loading rack reacts similarly to put additional pumps in service, thus making sure that each line will deliver its full capacity even when all loading stations served by it are in use. When the loading-rack valves are closed, the sequence of operations is reversed and the pumps are shut down. The enlarged section of the delivery line downstream from each pressure tank reduces the velocity of the flow and eliminates the possibility of pulling a vacuum on the tank and causing hydraulic shock.

where the fuel is run directly into storage tanks through a manifold, strict watch is kept for the appearance of the go-devil, and as soon as it arrives the flow is switched to another tank.

The loading docks, or racks, where the delivery vehicles receive their supplies, have 68 outlets and room enough so that eighteen standard fuel trucks and four transport trailers can be loaded simultaneously. The docks are served by an automatic air-operated pressure system that maintains maximum flow regardless of the number of trucks being filled, and consequently reduces the loading time to the practicable minimum. The pressure system was designed and installed by Socony-Vacuum engineers, and it is believed that this marks its first use in a tank-truck loading operation.

Fuel flows by gravity from the storage tanks to 22 Ingersoll-Rand 7½-hp. Motorpumps, each of which can deliver 400 gpm. at 21½ pounds pressure. Seven of them handle No. 1 fuel oil, seven Mobilgas, and two groups of four each deliver No. 3 fuel oil and Mobilgas special. A header or supply line for each of these four fuels runs from the pump house to the loading docks. Connected with each line, just downstream from the pumps, is a 1000-gallon pressure tank. The lower half of each tank contains fuel and the upper part is charged with air at 30 pounds maximum pressure, the air being supplied by a 1½-hp., tank-mounted compressor having a piston displacement of approximately 8 cfm. A tubular sight gauge on the outside of each tank shows the liquid level at all times. Whenever the latter rises, an attendant opens an air-pressure valve for a few seconds to lower the liquid level to normal position. It is necessary to do this every two or three days, depending upon the temperature and other conditions.

The fuel lines extending to the loading docks are always under pressure. When a truck drives up and a valve is opened to fill it, the pressure in the line drops, and this drop is transmitted to the appropriate pressure tank. When the tank pressure is lowered by 1½ pounds a pressure switch is operated, and this, in turn, actuates a magnetic switch that starts one of the Motorpumps. As other loading-dock valves are opened, additional units are put in service. Accordingly, each rack operates at full capacity even when all loading stations are in use, whereas under the usual procedure at bulk plants only one pump may be running when two or three trucks are drawing fuel from the line. As each valve is closed, the tank pressure is restored to normal and the pumps are progressively shut down. As a safety measure, all can be stopped by any one of several push-button controls that are located at strategic points throughout the plant, and they cannot be started again until that particular button has been reset.

Each delivery line is increased in diameter for a distance of approximately 20 feet throughout the section where it is connected with its associate pressure tank. This serves to reduce the velocity of the flow through the line to about 2 feet per second, thus eliminating Venturi action which would otherwise tend to pull a vacuum on the tank and cause hydraulic shock that could amount to as much as 400 or 500 pounds per square inch.

The pressure system does away with the usual maze of electrical controls, conduits, and wires, and its automatic and foolproof features leave nothing for the truck drivers to do except turn the valves on and off. By shortening the loading time and, consequently, by increasing the number of hours a truck has for making deliveries, the company is able to meet the demands for fuel which have grown steadily since the end of rationing.

The Navy's Gyro Gunsight

IF YOU saw the Navy film *The Fleet That Came to Stay*, you may have wondered about the strange boxlike object with long tubes that was operated by antiaircraft gunners on our warships. It is now revealed that this is the new Mark 14 gunsight, the Navy's secret weapon that was developed by the Massachusetts Institute of Technology and the Sperry Gyroscope Company to smash Japanese air attacks on our fleet. Without this remarkable gunsight every ship in the Pacific squadron might have fallen prey to Japanese Kamikaze attacks and, further, our troops probably could not have landed on Okinawa.

The development of the gunsight was started in 1940 by Sperry engineers in collaboration with Dr. C. S. Draper of M.I.T. The aim was to apply the gyroscope to a computing sight for heavy guns on warships. The gyro was recognized to be especially well suited for this purpose because it maintains its position in space regardless of a ship's roll and pitch, something mechanical computers cannot do. For this reason, gyro-controlled gunsights later enabled our tanks to shoot straight while in motion by holding their weapons on a true horizontal line no matter how much the tanks pitched and rolled over rough surfaces.

The first major test of the new gunsight by our naval antiaircraft guns in the Pacific was on October 26, 1942, when *Battleship X*, later identified as the *South Dakota*, destroyed virtually every plane in an attacking Japanese force. This was not very long after the powerful British warships *Repulse* and *Prince of Wales* had fallen quick and easy victims to hostile bombers, and it was apparent that something important had happened in the meantime to render our ships practically immune to aerial attack. Eventually, 85,000 of the Mark 14's helped to cripple the Nipponese air force to such an extent that only occasional raids proved successful. Because of them, our Navy was not afraid to sail boldly within range of Japanese land-based planes.

The Mark 14 was the answer to the Navy's need for a more maneuverable defense weapon. It provides unremitting control, permitting guns to be aimed accurately at a target moving at high speed, its gyroscopes automatically computing the "lead" of the plane under fire. The gyroscope can do this because of its inherent characteristic known as "precession." This is displayed when a force is applied to the gyroscope that tends to change the plane of rotation of its spinning wheel. Precession was defined by Elmer A. Sperry as follows: "When a gyroscope is subjected to a force which tends to alter the direction of its axle in space, the force meets with great resistance, and the gyroscope wheel will turn about an axis at right angles to the axis about which the force was applied." For example, if the gyro rotor is spinning in a vertical plane, and a finger is applied to its supporting ring in an attempt to push it off the vertical, the rotor, instead of tipping, will turn to one side but remain in the vertical position. If the pressure is applied from the opposite side, it will turn the other way.

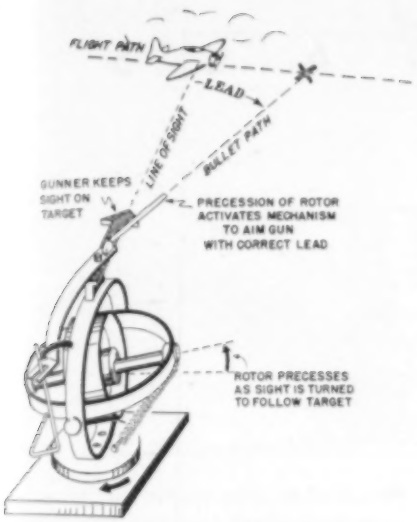
As it is definitely known how a gyro will precess when such a force is applied to it, advantage is taken of the movement to control various actions such as opening or closing valves or operating electrical circuits. The gunsight makes use of what is known as a "rate gyro." A spring is attached to the gyroscope, and the faster the latter is made to precess, the greater the force that is exerted on the spring. In the case of the gunsight, the rate at which the gunner moves his weapon in following a target determines the force on the spring. Fast movement gives greater force than slow movement. This force is immediately transmitted to a mechanism that offsets the line of sight from the line of the gun bore. Consequently, when the gunner is sighting a target, the weapon is actually pointing just far enough ahead of it so that the enemy plane will fly into the bursting shell.

One part of the optical system within the gunsight is a lighted reticle that is projected to the gunner's eye. Moving the sight so that the reticle is superimposed on the moving target, the sight automatically computes where it will be when the projectile completes its flight. Also, it automatically compensates for projectile drop owing to gravity. It provides the solution for problems such as computing the variables in short-range firing, continuously feeds data to the guns, and frees gunners to "track" the enemy.

There are two gyros to a gunsight. They are delicate instruments and some of their parts have to be made with great-

NAVAL AIRCRAFT GUNS IN ACTION

These weapons were so effective against Japanese bombing forces that our fleet was able to sail up close to islands under attack without being greatly molested. In the Battle of the Marianas, so many hostile planes were brought down in one day that the Navy gunners referred to the action as the "Marianas' Turkey Shoot." At the close of the war the enemy's air force had been greatly reduced and most of the remaining planes were being saved for use in the expected invasion of the home islands.


FLIGHT PATH
LEAD
LINE OF SIGHT
BULLET PATH
GUNNER KEEPS SIGHT ON TARGET
PRECESSION OF ROTOR ACTIVATES MECHANISM TO AIM GUN WITH CORRECT LEAD
ROTOR PRECESSES AS SIGHT IS TURNED TO FOLLOW TARGET

HOW GYRO DIRECTS FIRE

To any force tending to alter its plane of rotation, the gyroscope reacts by turning about an axis at right angles to the axis about which the force was applied. This movement is called precession. As the gunner turns his weapon to follow the speeding airplane through his sights, the gyro precesses and exerts force on the spring attached to it. This force is transmitted through mechanisms that automatically point the gun on a line that gives it the correct "lead" of the moving plane. All the gunner has to do is keep a bead on the target and pull the trigger.

er precision than those of a watch. The rotors are only about 2 inches in diameter and weigh less than a pound apiece. Each is spun at 10,000 to 11,000 rpm. by a jet of compressed air impinging upon its slotted outer surface. The compressed air is supplied by a small diaphragm-type compressor or pump that is operated through an eccentric by a fractional-horsepower motor. The unit has a capacity of 1½ cfm. and discharges at 8 pounds pressure. The system is a closed one—the air circulates to the gyroscope and then back to the pump through hoses of Resistoflex having a core of Compar.

It is important that oil, water vapor, or other extraneous substances that might cloud the optical system be excluded from the air. As the compressor operates without lubrication, no oil can get into it from that source, and the entrance of sea air to the sight is prevented by sealing the entire air system. At two points silica gel is applied to absorb any moisture that may be present. One of these driers is placed where all the air in the system flows through it. The other is attached to the compressor breather to extract moisture from the make-up air admitted to offset losses. This is an 8-ounce bottle containing silica gel and is mounted externally where it is visible at all times. The color of the silica gel undergoes a change from bright blue to pink when it is contaminated by moisture, and therefore acts also as an indicator.

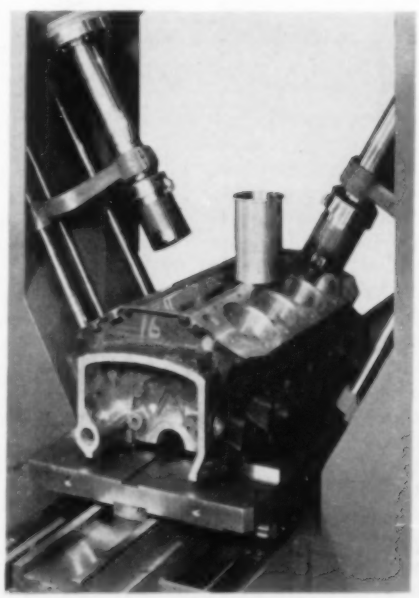
Early in the development of the gunsight it was realized that a prime requisite of perfect performance was an immaculate piping system for the compressed air. Tubing for this purpose had to be made of a material that would not slough off and clog tiny orifices—that would preclude the possibility of the entrance of oil or water vapors and yet retain its flexibility in temperatures as low as –20°F. Likewise, it had to withstand sudden and violent flexing every time one of the guns went into action. Sperry engineers had had extensive experience with tubing of Compar, a vinyl-resin derivative developed by the Resistoflex Corporation. They had used it for gyro installations and also for handling hydraulic fluid under variable pressure in testing gyroscopes. Because of the material's demonstrated suitability for these purposes, it was selected for the tubing on the Mark 14.

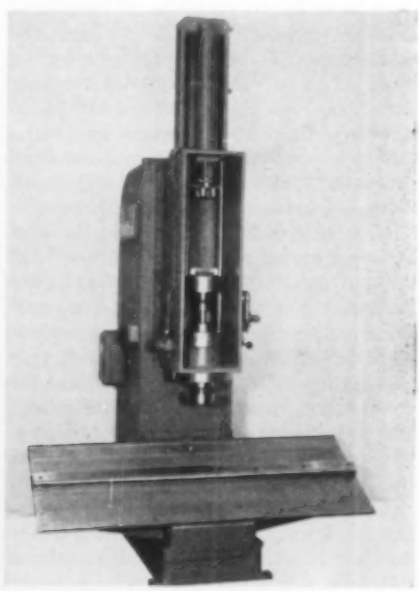
For some of the material in the foregoing article acknowledgment is made to A. B. Sperry, Product Engineer, Sperry Gyroscope Company.

Special Presses Expedite Assembly Work

THE work of assembling eight steel sleeves in the bores of a V-type cylinder block has been greatly simplified by a unique system of deep freezing, heating, pressure, and impact developed by a well-known engine manufacturer in coöperation with the Colonial Broach Company, which also designed and built the special presses used. To facilitate insertion, the liners are shrunk by refrigeration while the block is being heated to give the bores more clearance. When chilled, the sleeves are shoved in place, two at a time, by a hydraulically operated press with dual spring-loaded plungers. These come in contact with index grooves on the sides of the sliding fixture carrying the block and thus insure alignment with the bores. With this operation completed, the assembly is allowed to stand until it has reached room temperature.

At that stage in the process the liners have a tendency to "crawl" out of the bores and necessitate "setting." This is done by a press that exerts both hydraulic pressure and impact. The machine is equipped with an inclined platen that automatically aligns each row of bores with the piston and also has locating stops that successively position the block with precision. Surmounting the plunger column is a vertical air cylinder. This unit lifts a weight to the top of the column where it is tripped, dropping on the plunger just at the time it is bringing pressure to bear on one of the sleeves. The added impact thus provided helps to drive the sleeve back into the bore and sets it.

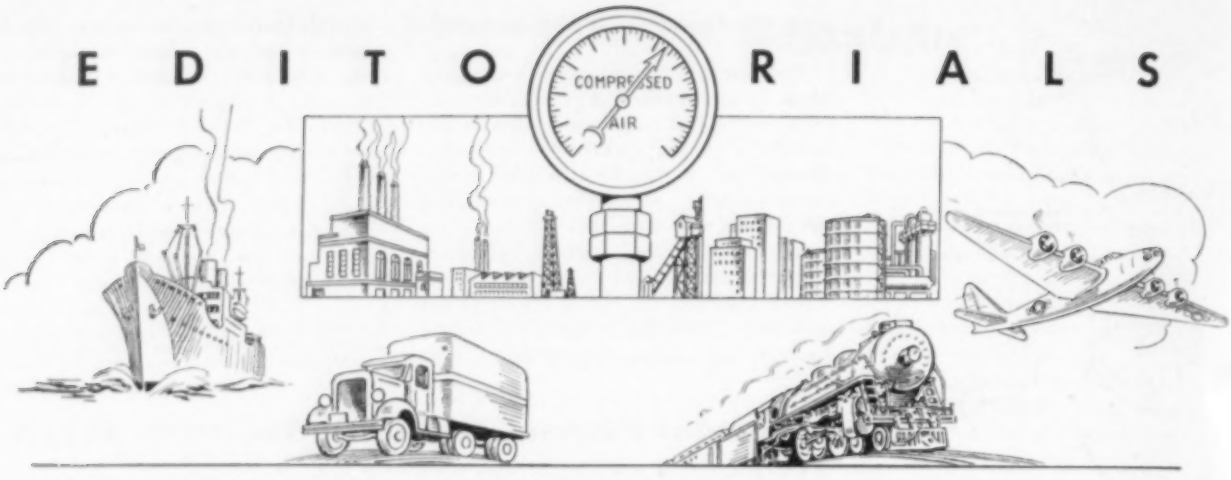




SPECIAL MACHINES

The picture at the left shows the working table and pistons of the hydraulic press that drives two chilled liners at a time into the heated engine cylinder block. The sliding fixture which supports the latter is indexed and aligns each pair of bores with the plungers. Note the sleeve standing on top of the block. The other machine, with the cover plate removed, "sets" the liners after they have been inserted. It exerts hydraulic pressure on each in turn and simultaneously drops a weight on the plunger to give it added impact. The pneumatic cylinder that raises the weight is mounted on top of the press and is actuated with air at from 60 to 80 pounds line pressure.

EDITORIALS



NEW HORIZONS

PETER PILTDOWN and his Pleistocene neighbors used stone for their weapons and utensils and made such clothing as they wore from animal pelts and vineal growths. They were limited to those things that Nature gave them. As civilization advanced, ingenuity began to supplement Nature, and more and more materials became available to meet mankind's increasing needs. This has gone on until there is seemingly no end to the trend towards diversification. It may be that we are even now only beginning to learn how to utilize most effectively the vast list of substances the human brain is devising for us.

Iron and steel, still basic commodities, take on new forms every day. Stainless steel opened new fields of service, and today we have many kinds of corrosion-resistant ferrous compounds and the metallurgist is continually giving us more of them. New ways of working metals into usable shapes are coming to the fore. Complex forms are now being molded close to finished dimensions from powdered metals, thereby saving much time in turning out completed parts.

New materials are invading spheres long preëmpted by others, and those that are dislodged are, in turn, seeking to perform other services. Glass, once considered fragile, has been toughened to serve as building blocks, piping, plumbing fixtures, and kitchen ware. On the other hand, cans are making inroads in the province of bottles, and paper also has seriously entered the container field. Stimulated by wartime progress, the lighter metals are pushing into some of the departments formerly ruled by iron and steel. An experimental aluminum boxcar is now in use and may be followed by many others.

In this age of chemistry, products born in the laboratory are playing great and growing parts in our daily lives. Plastics have mounted quickly over the horizon and are forging their way into many fields previously dominated by other materials. Plastic houses and auto bodies are perhaps just around the corner, and flexible plastics are reputedly about to bid for some of the shoe business traditionally reserved for leather. In fibrous form, at least one plastic—nylon—has established a definite place for itself in competition with lustrous, age-revered silk in the world of feminine glamour. Rayon and other artificial textiles have made truly sensational strides in the clothing industry. Synthetic rubber, born of the exigencies of war, is here in force, but its future is uncertain and will depend upon many considerations, both domestic and international in character.

The list might be extended indefinitely, which seems to bear out the truth of the statement that the only permanent thing in the world is change.

ATOMIC-BOMB BENEFITS

MERELY the bare announcement that it cost Uncle Sam two billion dollars to drop two atomic bombs on Japan suffices to indicate that a vast amount of equipment and man-hours went into the effort. As more information about the undertaking is divulged we are gaining a clearer picture of the almost incomprehensible scope and extent of the research that was involved. No one quibbles about the monetary outlay, for it has been pretty well established that the bombs shortened the conflict perceptibly and thereby saved thousands of American lives, unpredictable human misery, and also untold billions of dollars that otherwise would have been poured into the war chest.

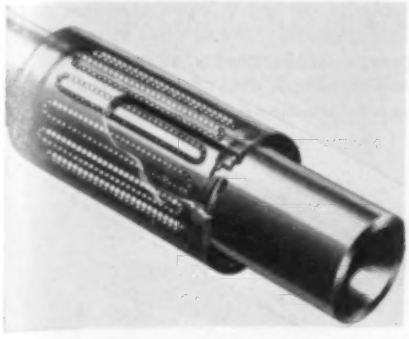
On these bases alone, the price was reasonable. We were playing for big stakes and we won. Even if we ignore the strictly military aspects of the bomb project, the nation, obviously, still got a real bargain. As more of the story of what went on behind the scenes is unfolded, it is apparent that industry will reap a tremendous harvest from the huge store of technical knowledge that was amassed during the secret operations.

Four methods of separating the uranium U-235 from ordinary uranium were developed in pilot plants, and three of them were placed in actual production. Regarding just one of these—the gaseous-diffusion process—we are given enlightening information by The M. W. Kellogg Company, which carried out the work in this particular field through its subsidiary, the Kellex Corporation. A recent Kellogg publication tells us that the successful development of this method "necessitated the creation of the largest chemico-physical process in the world; a single process employing more pumps, more diffusion barriers, more power, more instruments, and on which was concentrated more research and money than had ever before been expended on a single project. Totaling about 70 buildings and sprawling over 600 acres at Oak Ridge, Tenn., a $500,000,000 plant was built, creating almost overnight an entirely new industry based on gaseous diffusion through porous barriers."

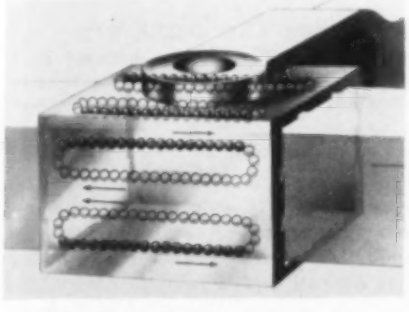
Here is a research laboratory that dwarfs anything previously conceived, and from the work that was done there industry of various kinds will reap incalculable benefits. New concepts, new techniques, and new equipment were devised that will serve in countless ways in the future. Better coolants, piping, heat exchangers, lubricants, pumps, packing, seals, valves, and instruments are among the specific things that were evolved to satisfy the stringent requirements. The Kellogg Company estimates that several thousand new or improved products and procedures will be available to American industry as soon as the Government releases them.

We can do little more here than hint at the scope of the investigations that were carried on in solving the problems of the various lines of endeavor. It is illuminating, however, to single out just one of them, that of pumping. It was necessary to operate pumps at velocities greater than the speed of sound, and in surmounting the difficulties involved more than 250,000 man-hours were expended on research—the equivalent of 100 years of work by one man.

Industrial Notes



What ball bearings have done to minimize friction in the case of rotating parts, ball bushings are designed to do for sliding members. The new bushing has been developed by the Thriftmaster

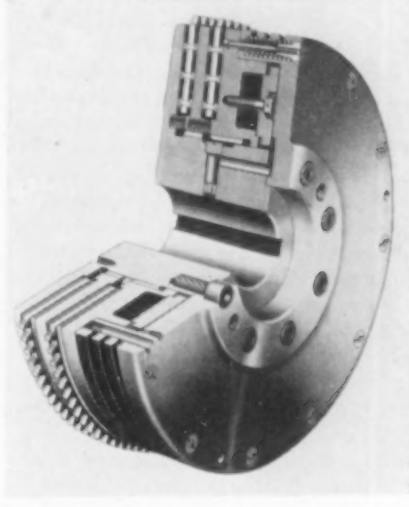


Products Division of Thomson Industries, Inc., and is said to permit unlimited travel of reciprocating mechanical parts whether round, square, oval, hexagonal, or otherwise in section. As the accompanying illustrations show, it consists of a series of ball circuits the arrangement of which can be varied to meet load requirements and the shape of bearing units. As the balls make their circuit, those on the top side carry the load while the others are on their way back through a clearance in the outer race member to take it up again, thus insuring continuous and free movement. Other advantages claimed for the longitudinal ball bearing, which is identified by the trade name Ball Bushing, are reduction in weight and longer service life of sliding parts, as well as of drive motors, gears, linkages, etc.

With the increasing use of powdered metals, it is of interest to learn that an expenditure of $300,000 has been approved for the building of an experimental powdered-iron plant on the Mesabi Range. The project is backed by the Range Resources Commission and has for its objective the utilization of Minnesota's enormous low-grade iron deposits. The plant is to be operated for the state by the Continental Machine Company and is designed to handle iron-carbonate slate. The conversion process was developed by C. V. Firth of the University of Minnesota School of Mines and is not patentable, says the U. S. Bureau of Mines, because it consists of a series of known chemical processes. Laboratory tests have proved the iron powder from this source to be of great purity and to be suitable for pressing and sintering into machine parts and tools possessing the strength of steel.

It is reported that the strength and performance of abrasive cutting wheels are improved by mixing ¼-inch milled fibers of Fiberglas with the silica, carborundum, etc. In the case of wheels 12 inches in diameter and ⅛ inch thick used to cut the bead from molded metal products, the addition has resulted in an increase in strength of 25 percent, while the maximum operating speed has been stepped up from 15,000 to 17,000 rpm. The heat generated is dissipated rapidly, and the metal shows no tendency to burn.

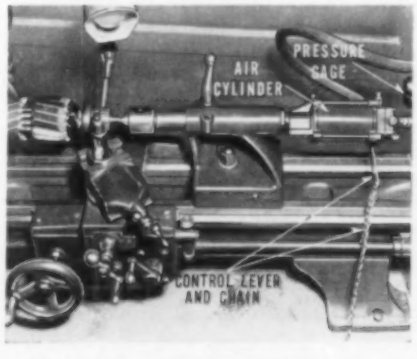
After more then three years of research and testing, Twin Disc Clutch Company has introduced an air-actuated clutch that is said to be ideal for remote-control set-ups and for heavy-duty operations where "feather-touch" engagement is necessary. The Model P, as it is designated, is similar to the Model E friction clutch and can, in many cases, be substituted for the latter with few alterations in equipment. The pneumatic type functions without a complicated linkage system and is designed so that the air can be fed in two ways, depending upon where the clutch is mounted. Maintenance is simplified because of the few moving parts. Other



than springs, these are: piston, piston seal, and floating plate. The springs are located at equidistant points on the periphery of the cylinder where they are easily accessible and hold the clutch in the disengaged position until air pressure is applied. Air at any desired pressure within certain limits may be used to insure slow or fast engagement and is controlled by a Westinghouse balanced air valve. The Model P is manufactured in sizes ranging from 14 to 36 inches and in capacities from 65 to 895 hp.

We are all familiar with the hazards of gasoline—we know that it is highly inflammable and must be handled with caution. It may therefore surprise many of us to learn that the Standard Oil Company of New Jersey has been instrumental in developing what is termed a nonexplosive gasoline. It's a by-product fuel, of which the supply is at present limited. It has undergone extensive testing, also by the armed forces, and will add measurably to the safety especially of flying because it will not burn unless actually ignited by fire.

Year-round mining of western lignite and subbituminous coals may be the outcome of experiments conducted by the U. S. Bureau of Mines at Golden, Colo. It is now the practice to produce such fuels only as needed, or to store them in huge concrete pits underwater because of the danger of spontaneous combustion. This is caused by heat induced by air currents flowing through the piles. Government investigators, says V. F. Parry, director of the Golden experiment station, have tried out a



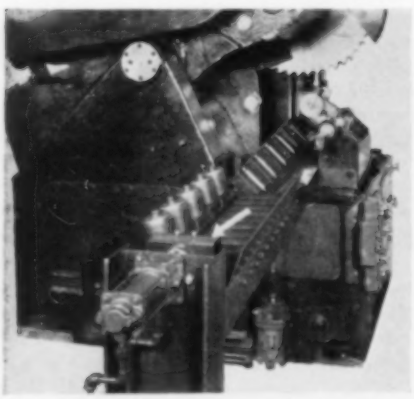
AIR-OPERATED

Foot control is a feature of this tailstock mounted on a lathe used for turning commutators at the Westinghouse small-motor division in Lima, Ohio. The pedal is connected to the control valve of the air cylinder by a lever and chain and, when depressed, releases the air. This causes the lathe center to withdraw and permits removal of the armature. Return of the pedal to normal position admits air to the cylinder and moves the center forward to hold the armature with uniform pressure. The gauge gives the operator constant check on the air pressure. This set-up leaves his hands free to handle his work and saves him the labor of shoving the center back and forth.

method introduced some years ago by the Dow Chemical Company whereby coal can be stored with safety. They have built up piles in layers compacted by huge rollers to a density of approximately 58 pounds per cubic foot, thus leaving no pockets through which air can filter into the interior. Further, tests have proved that the oxygen in the air that does penetrate the topmost layers is converted into carbon dioxide, which does not support combustion. Work twelve months a year for coal miners is just one of the advantages of this method of stockpiling. It also promises expanded markets and fuel at lower cost.

Metal is being welded to glass by a process invented in England and is being used, according to a news report, in the manufacture of electric heaters. The work is done by spraying aluminum in wire form on to specially heated glass. The metal is laid on in a zigzag pattern to provide a long conductor through which an electric current is then passed.

By mounting a marking unit at the end of the discharge conveyor of its circular billet saw, the Loma Machine Manufacturing Co., Inc., has made it possible to cut stock and to imprint identifying symbols on each piece with one set-up. The marker is air operated and consists of a metal block that is designed to hold four or five characters about 1 inch high. It is attached to the piston of a pneumatic cylinder actuated with air at from 60 to 100 pounds line pressure. Between marking stages the cylinder is precharged and the piston is locked by a device that is brought into action by a plate with which each billet comes in contact as it is carried down the inclined roller table of the discharge conveyor. When the cut-off piece pushes against the plate, the piston is unlocked and forced with sufficient impact against the flat surface of the billet to make a clear impression. The piston is then pushed back into the locked position by means of a 4-way valve controlled by the saw. Racks placed alongside the conveyor receive the finished work, which is dumped into them by a slight sidewise inclination of the rollers. The entire operation is automatic and can be regulated to synchronize with the speed of the saw, which varies with the stock being cut.



SAWS AND MARKS

When the cut billets reach the discharge end of the inclined roller conveyor, they are automatically marked by the unit indicated by the arrow. It is operated by the pneumatic cylinder in the foreground using air at from 60 to 100 pounds line pressure.

United States Rubber Company has announced an improved type of synthetic-rubber hose for aircraft and industrial applications. Carcass is built of Ustex, chemically treated high-strength cotton yarn; rubber used is resistant to temperatures up to 300°F. in cooling systems and 250° in oil lines. New hose is claimed to be much more resistant to pressure than former kind and is available in diameters ranging from ¼ inch to 2½ inches.

Porcelanite, a chemical in powder form, is a corrosion-resistant finish suitable for furnace setting, hot patching, door lining, and calking leaks between brick and ironwork. Material is said to withstand heat up to 3000°F. and harmful action of gases, flue dust, and slag. In the case of new construction, firebricks are dipped before laying, otherwise chemical is applied by brush or air spray.

Such a small matter as surfacing a table with sponge rubber may make all the difference between maintaining the speed of an assembly line and slowing down all the operations on account of one, as a large industrial plant discovered. Workers at one station had difficulty in picking up small metal parts, with the result that the conveyor traveled faster than they could put them in position and finish their particular job. When a thin slab of sponge rubber was fastened on top of the table at the suggestion of a B. F. Goodrich Company engineer, the fingers could readily grip the pieces and production moved along according to schedule. For this purpose a sheet ⅛ inch thick was adequate, but the thickness and density of the rubber depends upon the character of the part.

Portovent is the trade name of a new type of ventilating hose that can be compressed into a small space for transportation. It is a lightweight duct of sectional construction reinforced with metal rings from 2 to 5 inches apart and held firmly in place by a Neoprene-base compound, which also covers the entire inside and outside surfaces of the hose. Spacing of the rings depends upon the diameter of the hose, which ranges from 5 to 24 inches. The sections are 2½ feet long and can be coupled and uncoupled by hand without difficulty. The joints are said to be tight, and to remain so under the jerks or pulls encountered in service. For attachment to blowers or other air-handling apparatus are provided special fittings that permit coupling interchangeably with either end of any section. Ducts of any desired length can be assembled and are especially well

OPEN AND COLLAPSED

When compressed for shipment or storage, the 15-foot section at the top is reduced in length to 2½ feet as shown.

suited for use with portable manhole and tank ventilators, mobile air-conditioning and heating and cooling units, and for the control of fumes and dusts in process industries. Compression for packing is 6 to 1 over all, and more in the case of hose for light service. Portovent is made by American Ventilating Hose Company.

Dollinger Corporation has announced a liquid filter that permits the use of any straining medium that comes in sheets and can be crimped. The filter insert is known as the Slip-On and, as the illustration shows, consists essentially of an inner wire-cloth form and of an outer one to which the filtering medium is crimped. Both parts are finned and fit together. Top and bottom plates and seal gaskets complete the assembly, which is held in place by through bolts.

Slip-Ons may be covered with fabrics, plastics, or metallic materials resistant to hot or to corrosive liquids and for the removal of tiny particles of dirt. They permit of quick replacement or interchange, thus giving Staynew filter Model ELS a wide range of applications.

Industrial Literature

The Magic of Electronics in Air Filtration is a profusely illustrated booklet that treats the subject of electronic air filtration in nontechnical language that anyone can understand. Copies of it may be obtained from the American Air Filter Company, Inc., First and Central Avenue, Louisville 8, Ky.

McInnes Steel Company, Corry, Pa., has issued a new catalogue, *Tool Steel & Forgings*, describing its line of hammered crucible tool steels. It covers applications, analyses, hardening and tempering temperatures used to give specific Rockwell hardnesses and, in addition, contains a standard classification of extra charges for special sizes and services.

Two new bulletins are announced by Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y. Both cover equipment applicable to specific industries. Form 122 lists and describes products for chemical and process plants. Bulletin 105-A makes a similar presentation of equipment for ships and shipyards.

A new type of drill chuck in which a web of Neoprene—synthetic rubber—maintains jaw alignment and permits one chuck to take a wider range of drill sizes than it can usually accommodate has been developed by The Jacobs Manufacturing Company, Hartford 2, Conn., and is described in Bulletin 45-P.

Stainless and stainless-clad steels produced by Jessop Steel Company, Washington, Pa., are described in a new bulletin that is available upon request. Data on physical and mechanical characteristics, corrosion resistance, and properties in fabrication are included.

The many uses of "Gunite" are described in a new 72-page publication of the Cement Gun Company, Allentown, Pa. The booklet consists of the case histories of numerous construction and repair jobs on which guniting was advantageously employed. It is profusely illustrated with photographs and drawings and contains considerable engineering data.

Gerotor May Corporation of Logansport, Ind., has issued a new catalogue describing its air cylinders and valves. It includes essential data on seven models of nonrotating, double-acting air cylinders, a high-speed rotating air cylinder constructed of aluminum alloy, and various types of air-control valves. Copies of the publication, designated as Catalogue No. 50, are available upon request.

The Watertown Book of Plastics describes and illustrates various types of plastics made by a firm that has been in this line of business since 1915, which was soon after Bakelite came on the market. The first Watertown plastic was Neillite, a phenolic compound discovered by J. R. Neill while he was searching for a new waterproofing material. Since then, other plastics of both the thermoplastic and thermosetting types have been developed. The booklet gives essential information regarding all of them and describes the various methods employed in their manufacture. These materials enter into many finished articles, including tableware, laboratory equipment, toilet articles, instruments, and innumerable electrical and electronic parts. Copies of the booklet are obtainable from The Watertown Manufacturing Company, Watertown, Conn.

LIQUID OR GAS TEMPERATURE CONTROL PROBLEM?

These publications describe the NIAGARA AERO HEAT EXCHANGER and some of its applications. It accurately regulates the temperature of gases and liquids. Industrial plants using chemical and heat-treating processes have gained extra benefits from using this equipment wherever cooling water is used or any fluid is cooled to exact temperatures.

Some of the applications are: controlling temperature of liquid chemicals and intermediates in process; controlling jacket water temperature in power and process equipment; regulating the temperature of controlled atmosphere; controlling liquid bath temperatures.

As a cooler, the NIAGARA AERO HEAT EXCHANGER saves the cost of 95% of the water circulated.

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The Ingersoll-Rand Motorpump, especially constructed for bulk station duty, eliminates the difficulties often encountered in handling petroleum products. To reduce leakage is all-important. Ingersoll-Rand does this by employing deep stuffing boxes . . . special stick lubricant for sealing and lubricating the stuffing boxes . . . packing under the shaft sleeve and a gasket between the impeller and sleeve.

Highest efficiency is obtained by careful hydraulic and mechanical design, together with simple rigid and sturdy construction. Many installations testify to the long life and ease of maintenance.

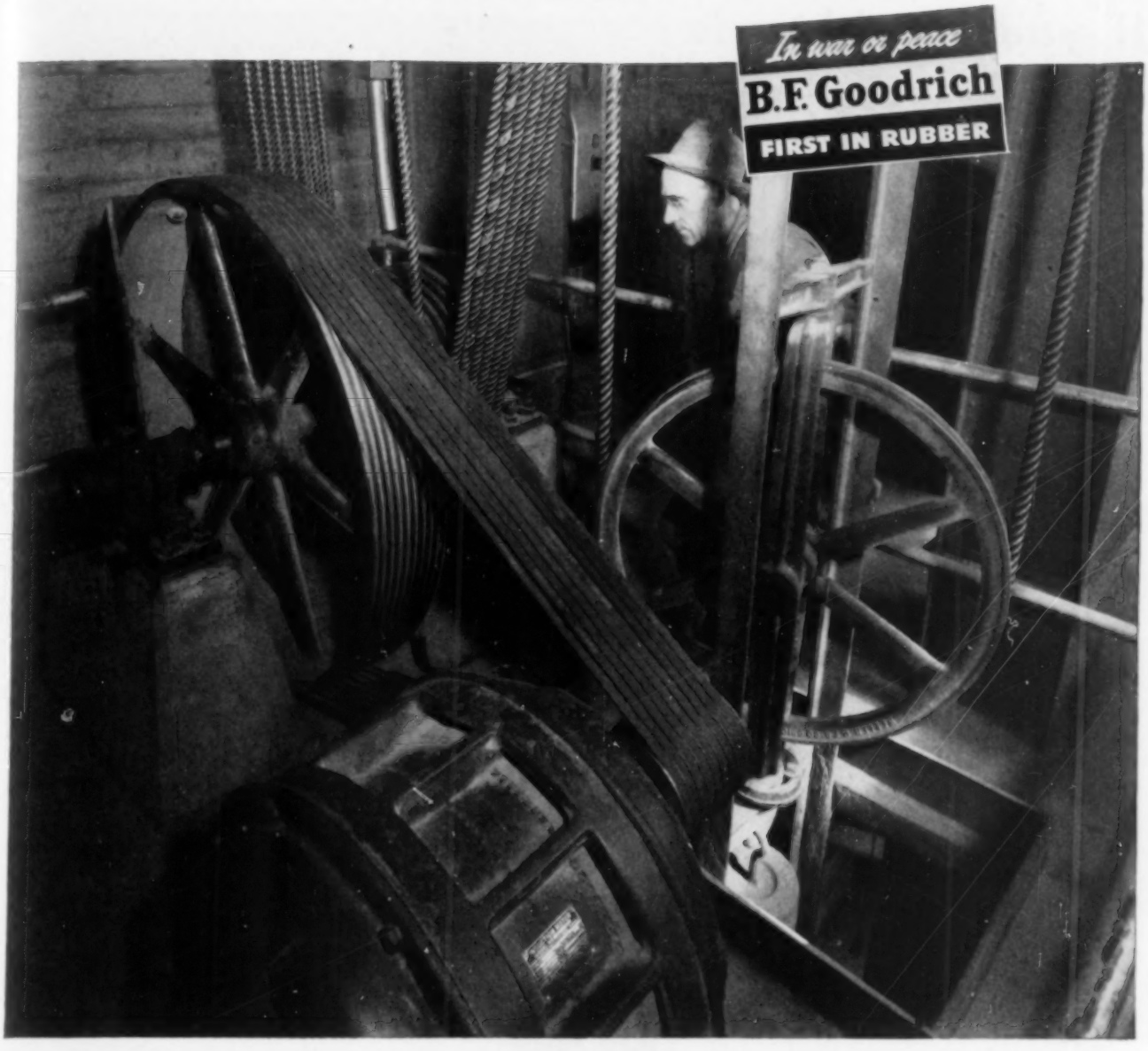
Motors used are of the explosion-proof type. The entire unit is completely weatherproof and may be installed outdoors without protective cover.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

9-745

Compressors • Air Tools • Rock Drills • Turbo Blowers • Condensers • Centrifugal Pumps • Oil and Gas Engines



First step in a loaf of bread

A typical example of B. F. Goodrich development in rubber

WHEN a grain elevator breaks down, some miller doesn't get grain and a lot of people don't get bread. And the elevator where this picture was taken was breaking down — often.

They used a chain to run the big belt that carries grain. At the high top of the elevator, it was a nuisance to grease so it didn't get greased — and breakdowns were frequent.

The chain and gears finally went to pieces for keeps, and the owner decided to replace them with a rubber V-belt drive that wouldn't need any lubrication. The only trouble was he was told there wasn't room enough unless he wanted to tear out part of a concrete wall and floor to make room.

But instead of doing that he called for help from B.F.Goodrich. He learned that B.F.Goodrich engineers had, just a short time before, developed an entirely new kind of V-belt—more than twice as strong as any other belt because it had two wire cables, called grommets, buried in the rubber of each belt to give it strength, absorb shock and make sure of positive drive at any speed.

B. F. Goodrich engineers studied the problem, then recommended and installed a drive using these new wire grommet V belts. Because of their strength only a few were needed; there was plenty of room for them. Because they require almost no attention, maintenance costs have just about been eliminated, and the grain keeps moving. In addition they're clean and quiet — no grease or dirt, no clanking. All these are typical results of the B. F. Goodrich research that has meant so many important improvements in rubber products for industry. *The B.F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich

RUBBER *and* SYNTHETIC *products*

If your problem is

DUST, OIL or MOISTURE

in the Compressed Air you use

for:

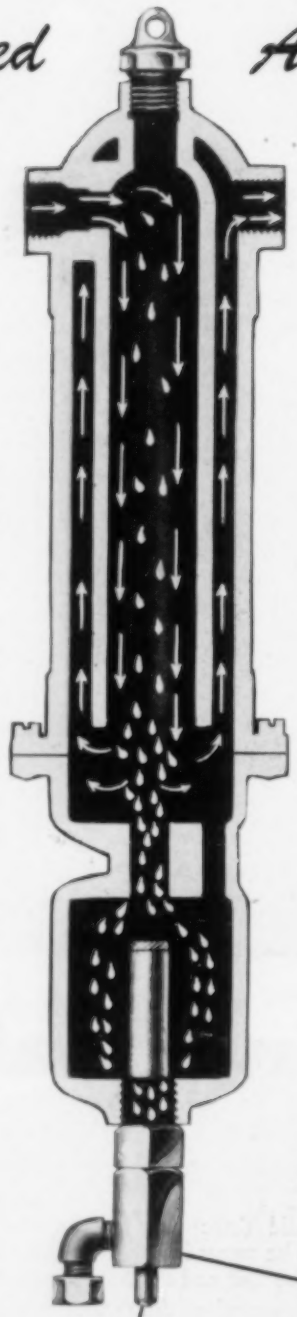
Spray Painting
Sand Blasting
Cleaning Machinery
Spraying Anti-rust Solution

Drying Washed Cars
Operating Pneumatic Machines

Dry Cleaning Eggs
Cleaning Upholstery
Drying Bottles
Blowing Out Molds
Cleaning Motors
Operating Recording Instruments

Blowing Glass
Cleaning Hats
Air Chucks
Metal Spraying
Drying Grain

or any other application



Then YOU NEED the DEXTER-SWENDEMAN Automatic Air Separator!

The continuous ejection feature of the Dexter-Swendeman Air Separator insures that no moisture or dirt is trapped to return to the air stream later. No attention is required, for the Dexter system is fully automatic.

The greater efficiency, better results and reduced spoilage from contamination usually pay the modest cost of this installation in a short time.

Write today for literature which you will find very helpful in solving your compressed air problems the Dexter-Swendeman way.

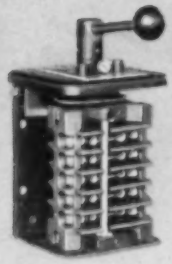
A-6

The **LEAVITT**
MACHINE COMPANY
ORANGE, MASSACHUSETTS

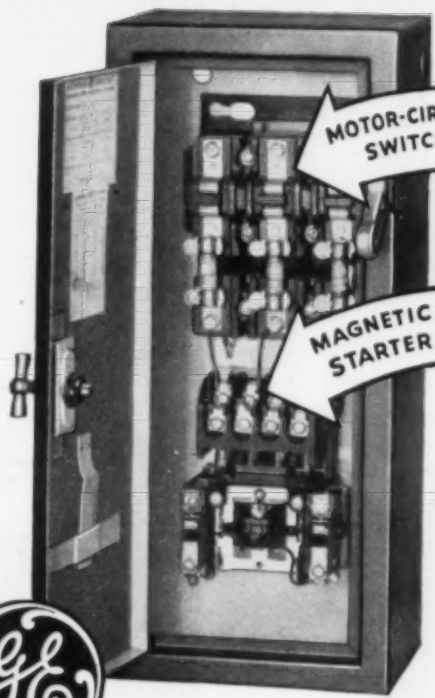
SWENDEMAN
Automatic Air Separator
A DEXTER PRODUCT

MOTOR STARTERS

FOR EVERY MACHINE APPLICATION



Small size—general purpose. Our small-size switch is cam-operated and spring-return to the off position. This particular device is recommended for single-speed reversing service or for two-speed non-reversing service.

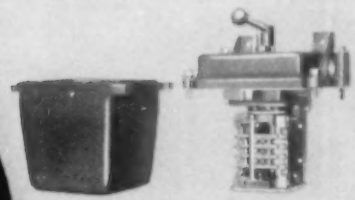


WHY BUY TWO DEVICES WHEN ONE WILL DO THE JOB?

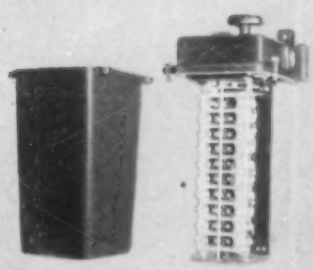
This G-E COMBINATION STARTER gives you in a single package both a motor-circuit switch and a magnetic starter

★ DEPENDABLE ★ ATTRACTIVE IN APPEARANCE ★ DESIGNED TO BLEND WITH MODERN MACHINES

For full-voltage starting of squirrel-cage a-c motors



Small size—dust-tight and watertight. The small size, too, comes in a variety of enclosures to meet different operating conditions. An example is this three-pole, reversing, rotating-cam switch in a watertight and dust-tight cast-iron case. It provides one point forward and one point reverse.



Multispeed—dust-tight and watertight. Rotating-cam switches come in enclosures to meet your needs. Here is a reversing, multispeed, rotating-cam switch in a watertight and dust-tight cast-iron case. This switch provides four speeds forward and one speed reverse.

INDUSTRIAL CONTROL

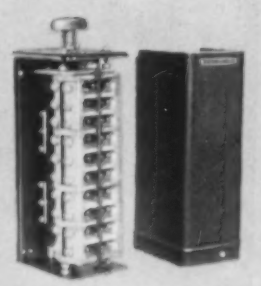
When you need motor starters, be sure to investigate G-E's complete line—perhaps some may give you important savings in time, space, or materials.

Take combination starters, for example—because you buy one packaged unit, less time is required for ordering and for installation. You can save space, too, by mounting them in small, unused places either near to or remote from the operator. And critical materials are conserved because these starters have less copper wire, steel conduit, and fittings than separately mounted devices.

Also shown here are other G-E starters—leaders in their field. They range from a general-purpose type of rotating cam switch to a full-voltage, multispeed magnetic starter. Frequent starting, remote control, different starting speeds, and many other special requirements can be obtained by selecting one of these starters.

And all G-E starters come in a variety of enclosures designed to meet different operating conditions.

We'd like to send you any additional information you may want. And, remember, our engineers will be glad to assist you in selecting exactly the right starter for your needs. Get in touch with your local G-E office today. Or if you prefer, write directly to General Electric Company, Schenectady 5, N. Y.



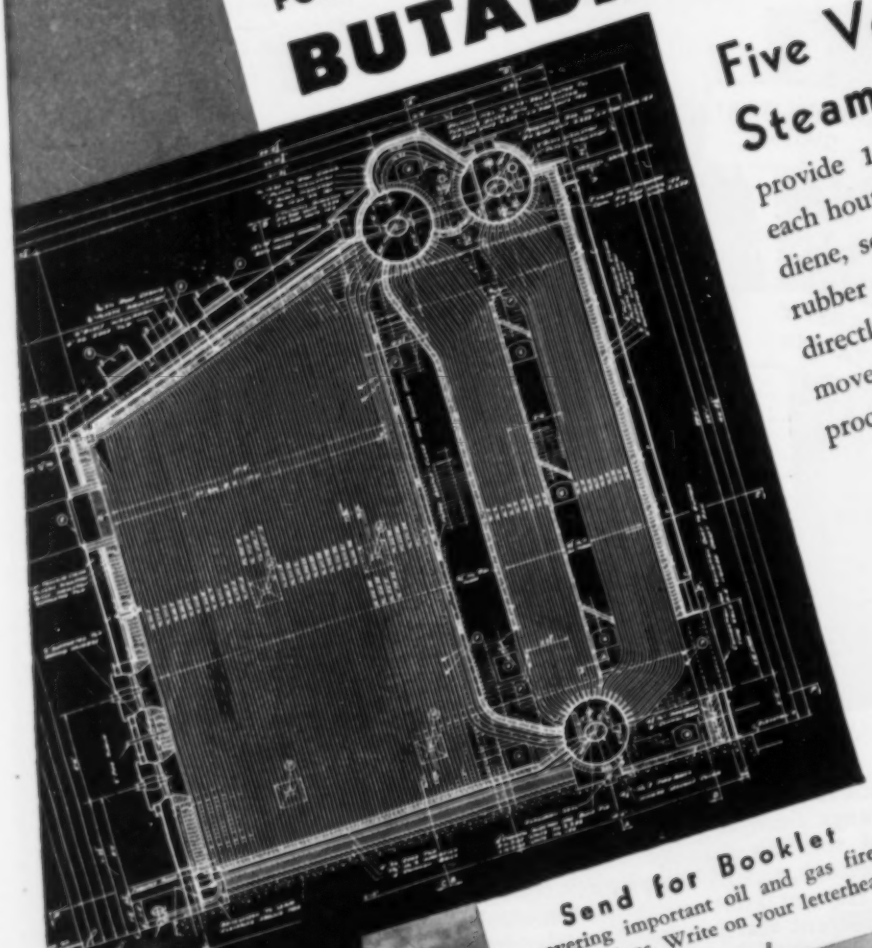
Multispeed—general purpose. This general-purpose type of rotating-cam switch is available for single-, two-, three-, or four-speed motors requiring either forward and/or reversing service. Particular care has been taken to insure you of obtaining the long-lived service that you want in a switch.

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

676-137C-8919

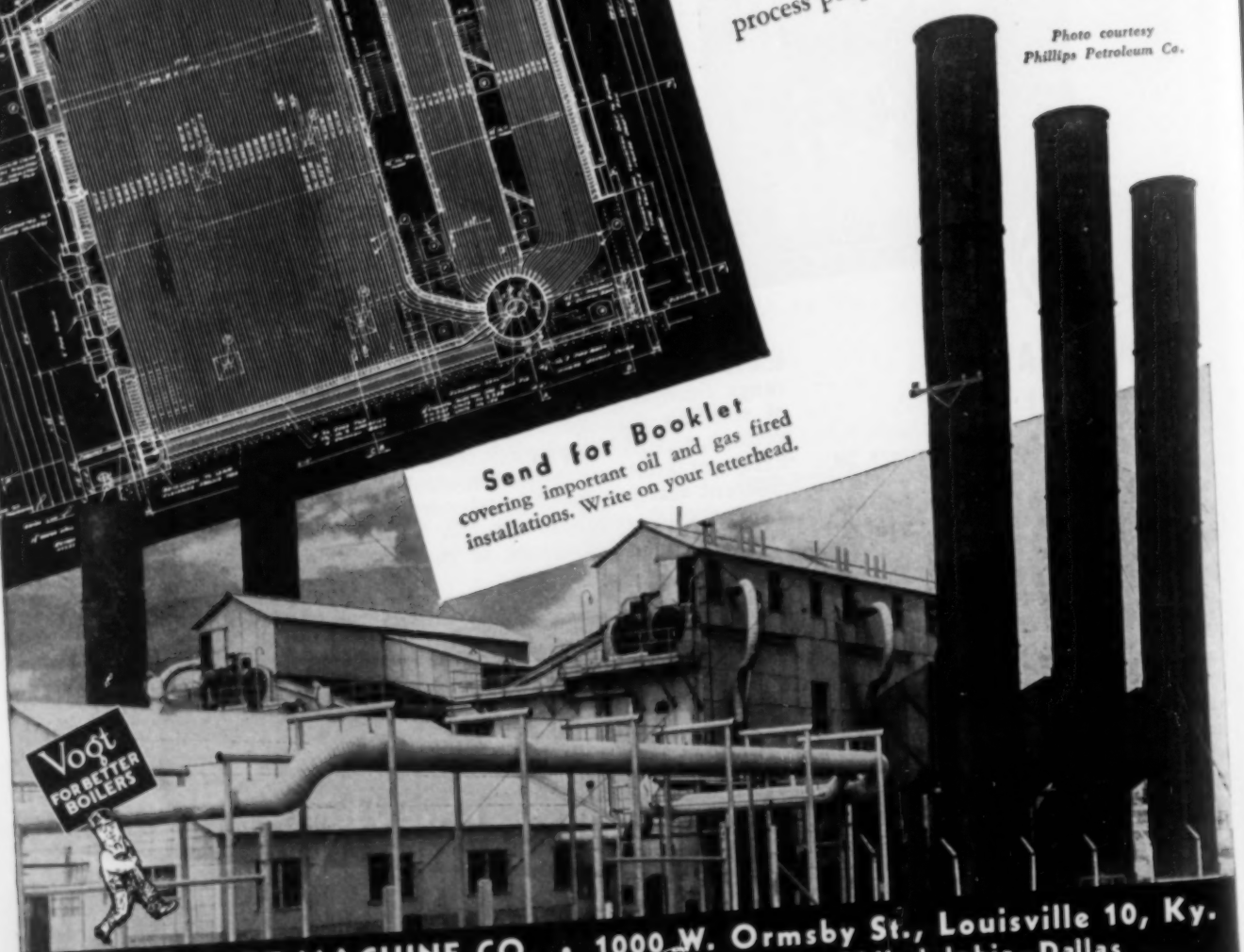
1,250,000
Pounds of Steam Per Hour
FOR PHILLIPS PETROLEUM CO.'S BORGER, TEXAS
BUTADIENE PLANT



Five Vogt Class VR Steam Generators

provide 1,250,000 pounds of steam each hour for the production of butadiene, so vital to America's synthetic rubber program. The steam is used directly in process and for prime mover power with exhausts for process purposes.

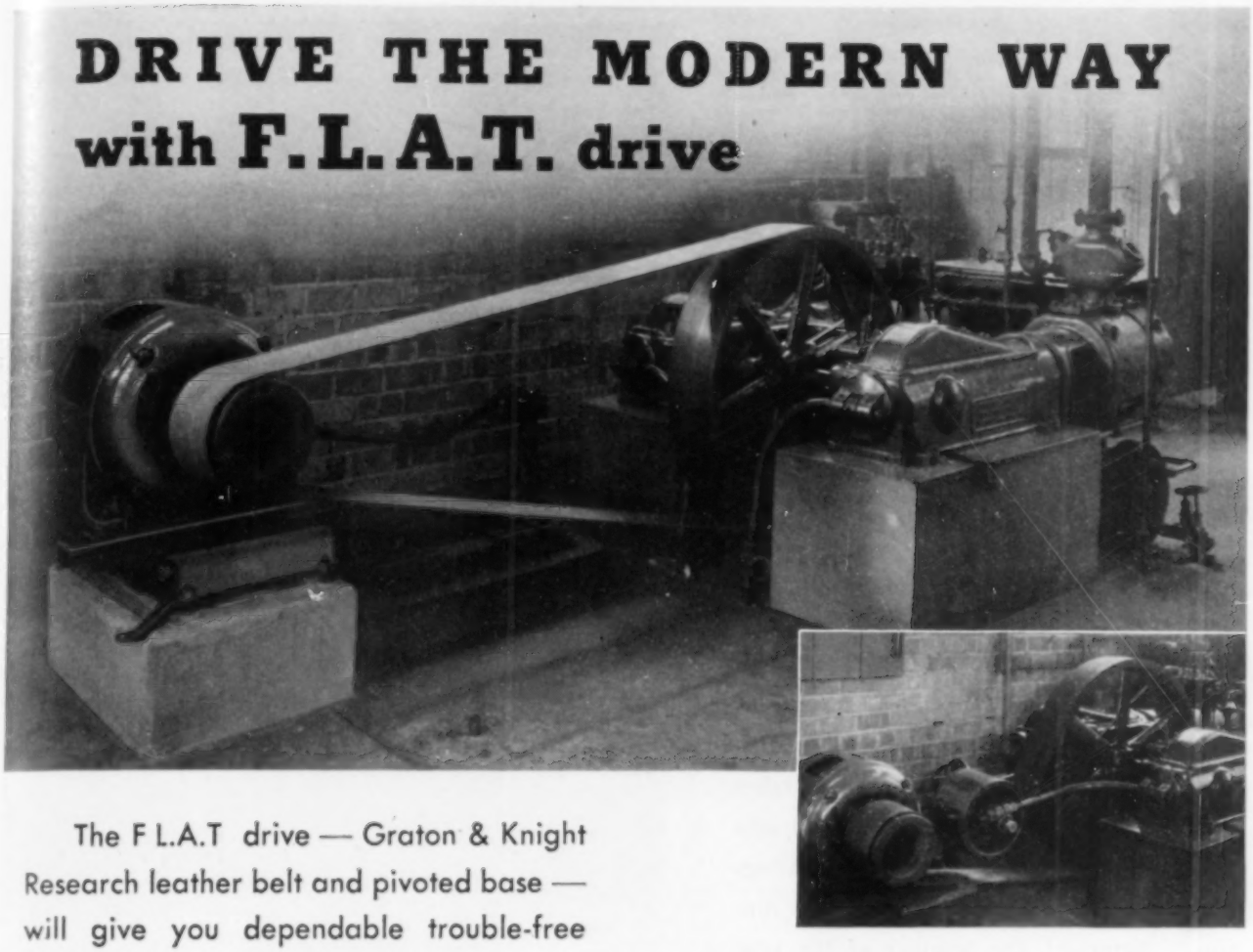
Photo courtesy Phillips Petroleum Co.



Send for Booklet
covering important oil and gas fired installations. Write on your letterhead.

HENRY VOGT MACHINE CO. • 1000 W. Ormsby St., Louisville 10, Ky.
Branch Offices: New York–Chicago–Cleveland–Philadelphia–Dallas

DRIVE THE MODERN WAY with F.L.A.T. drive



The F L.A.T drive — Graton & Knight Research leather belt and pivoted base — will give you dependable trouble-free service on your compressor drives.

The pivoted base automatically maintains the proper tension whatever the load characteristics may be: high starting, fluctuating or shock.

Research leather belting possesses maximum flexibility, high tensile strength, high co-efficient of friction and natural elasticity — just the expectant qualities to assure the success of your toughest compressor drive.

The Proof: In a large chemical plant, the idler shown in the small illustration was eliminated and a Flat Leather Automatic Tension drive was installed. Belted by an 8" double Research this compressor drive has been operating 12 hours a day. **In over two years the belt has required no take-ups — the drive, no adjustments.**

This modern F.L.A.T. drive transmits more power, eliminates idler bearing replacement and increases belt life.

Write Graton & Knight Company, 365 Franklin St., Worcester 4, Mass., for 56-page manual, giving engineering data on this and other types of drives.

GRATON AND KNIGHT

Research Leather Belting

The most complete line . . . manufactured under one control from green hide to finished product. Graton & Knight distributors are listed under "Graton & Knight" in "Belting" section of Classified Telephone Directory and THOMAS' REGISTER.

● *Used for unloading, salvage and essential harbor clearing chores, this 100-ton crane, built by DRAVO CORP., has a 135-foot boom with a 360-degree traverse. Its base is an all-steel barge 140 feet long with a beam of 70 feet.*

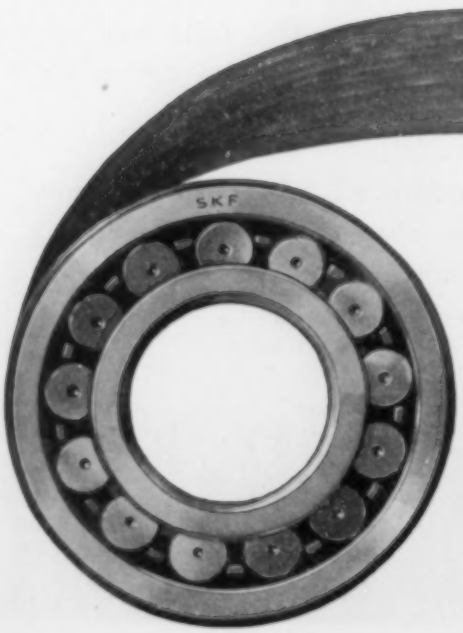
Plus-performance for

Big Lifts!

It takes tough bearings to work on this 100-ton Crane that picks up 75-ton locomotives as though they were toys. It takes compact bearings with built-in alignment unaffected by dynamic and static misalignment, distortions, weave or warpage. It takes bearings that need no adjustments and only infrequent lubrications. It takes bearings with low friction for easy starting and running. Naturally, the bearings at the vital points are SKF Spherical Roller Bearings.

5882

SKF INDUSTRIES, INC., PHILA. 34, PA.



SPECIFY

SKF

BEARINGS

GET THE FACTS

ON ENGINEERED AIR AND OIL FILTRATION

AIR-MAZE
engineered air and oil filtration
Type "A" Air-Maze panel on Venn-Severin Diesel used in New York schools.
Large Air-Maze oil bath filter in diesel compressor plant at Gatun Locks, Panama Canal.
Bank of Air-Maze filter panels installed in one of the world's largest department stores.
VENTILATING AIR FILTER PANELS • OIL BATH AIR FILTERS • MULTIMAZE AND UNIMAZE AIR FILTERS • OIL-AIR SEPARATORS • OIL FILTERS • FILTER-SILENCERS • BREATHER FILTERS • MOISTURE ELIMINATORS • HUMIDIFYING and SPECIAL PANELS
AIR-MAZE CORPORATION
5200 Harvard Avenue • Cleveland 5, Ohio

This new catalog, No. SC-445, illustrates many Air-Maze developments that can save you both time and money. Air-Maze filters are guarding against damage from dirt in buildings, factories, residences . . . trains, planes and ships . . . engines and compressors . . . and in many special applications. Because of the reputation enjoyed by Air-Maze as a pioneer in the air filtration field, Air-Maze engineers have been given all types of filtration problems. In solving these problems, they have developed over 3000 different filtration units. Bring your filtration problems to Air-Maze for the correct solution.

AIR-MAZE CORPORATION
5200 HARVARD AVENUE
CLEVELAND 5, OHIO

JUST OFF THE PRESSES!

Send today for your **FREE** *Copy*

IF IT USES AIR . . . USE

AIR-MAZE

ENGINEERED AIR FILTRATION

• Oil bath type filters and filter-silencers • Cleanable filter panels for air-borne dirt, oil, grease and liquids • Oil-wetted type filters and filter-silencers • Exhaust spark arresters • Gear case, crankcase and tank vent breathers • Oil-separators for engine crankcases • Full-flow type cleanable oil filters

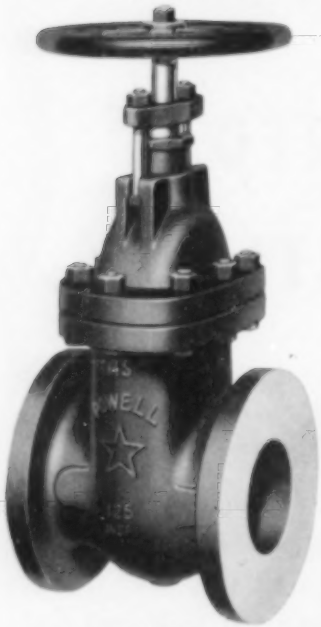
There's a POWELL VALVE for every Compressed Air service

One hundred years ago Powell started making valves for Industry and ever since that time the name "Powell" has signified leadership in the field of dependable flow control equipment.

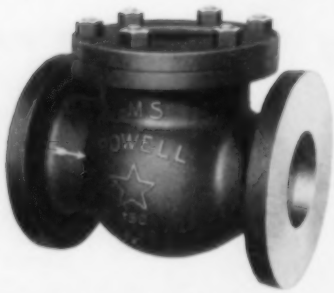
Today Powell makes a complete line of valves especially adapted to meet the requirements of every kind of service in the use of compressed air. This includes valves of all types, designs, materials and pressures necessary for controlling the flow of compressed air and also of water for cooling air compressors. A few examples of the complete Powell line are shown here.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES



125-pound Iron Body Bronze Mounted or All Iron, inside screw, non-rising stem Gate Valve.



150-pound Iron Body Bronze Mounted Horizontal Lift Check Valve with vulcanized composition disc.

150-pound Bronze Globe Valve with composition disc.

200-pound Bronze Gate Valve with renewable disc.

125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.

200-pound Bronze Globe Valve with regrindable, renewable seat and disc.

200-pound Bronze Dashpot Check Valve. Because of the cushioning effect of the plunger in the dash-pot, the seating of the disc is practically noiseless.

125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Globe Valve.

POWELL VALVES

A Byword in Wire Rope: "BUY ROEBLING"

—FOR 6 BIG REASONS!

YOU LEARN A GREAT DEAL from individual service records about the efficient performance, the low average cost of Roebling "Blue Center" Steel Wire Rope. But records tell you only part of the story . . . of its toughness, its reserve strength, its basic dependability under *all* conditions of operation.

What makes "Blue Center" a rope you can choose with full confidence? The Roebling ***reputation,*** for one, and the superior Roebling-made ***steel*** in the wires.

There's the ***skill*** born of a century's experience that goes into the rope's fabrication, the modern, unsurpassed ***facilities*** used.

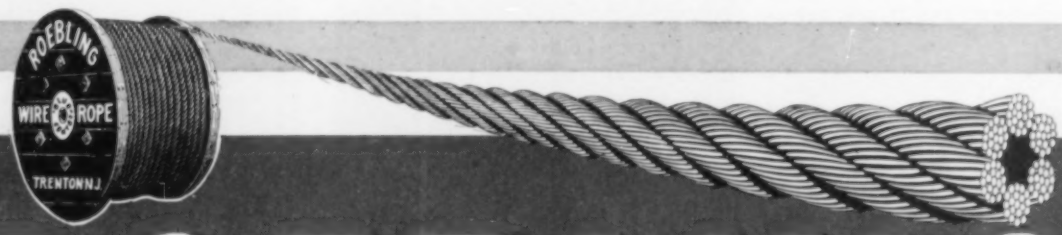
Add to the never-ending ***research*** that gives you longer rope life, the practical ***engineering*** that assures the best rope for your purpose.

Remember those facts when you order from America's first wire rope maker. They back up the performance you can expect from every reel of Roebling Wire Rope, preformed or non-preformed . . . and every correctly designed Roebling "Blueclad" fitting.

Now that increasing quantities of Roebling Wire Rope are available, we suggest you place your orders early. Call or write our nearest office . . . a Roebling engineer will help you select the correct rope and get full productive life from it.

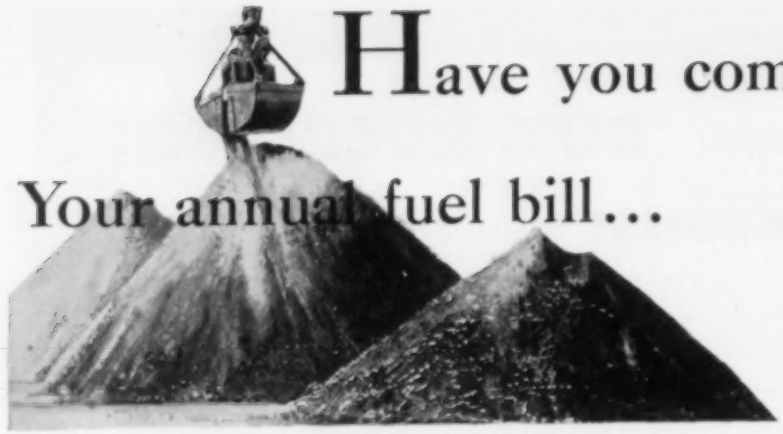
JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

WIRE ROPE AND STRAND • FITTINGS • SLINGS • AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • COLD ROLLED STRIP • ROUND AND SHAPED WIRE • WIRE CLOTH AND NETTING • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS SUSPENSION BRIDGES AND CABLES • ELECTRICAL WIRES AND CABLES • AERIAL WIRE ROPE SYSTEMS



ROEBLING

PACEMAKER IN WIRE PRODUCTS



Have you compared...

Your annual fuel bill...

with the original cost of your boilers?

If you do compare – and your operation is anyway typical – you'll find a single year's fuel bill is –

nearly as much as,
equal to,
or greater than

– the total original cost of your boiler installation. Just think – in 10 years' operation – an installation costing $50,000.00 may burn up fuel worth $500,000.00, or more.

Doesn't such a comparison give a jolt to the customary attitude toward first cost of equipment?

Doesn't it – instead – focus attention on such questions as – Will my next boiler installation be able to burn *efficiently* the lowest cost coals available to my plant? Will it be able to burn a sufficient variety of such coals to make me independent of changes in the coal market?

Two actual examples – many similar ones are on record – are described in the box. Read them, and if you are approaching the time when you will need a new boiler, consult C-E where you will find (1) a viewpoint that is concerned primarily with high return on your investment in terms of low annual fuel cost, and (2) a line of equipment adequate for any fuel or steam requirements.

Thus sound economics will be combined with sound engineering and the right equipment to give you – not the cheapest installation you can buy – but rather one that will keep the all-important fuel bill down to a minimum. With present high fuel prices and no prospect of post-war reduction, such an installation now offers the opportunity of greater economies than ever before.

A-907-A

TWO EXAMPLES TO PROVE THE POINT

A confectionery manufacturer operated a medium sized C-E Unit at moderate rating during 1944. His fuel cost was $32,000. The original cost of the unit was $30,061.

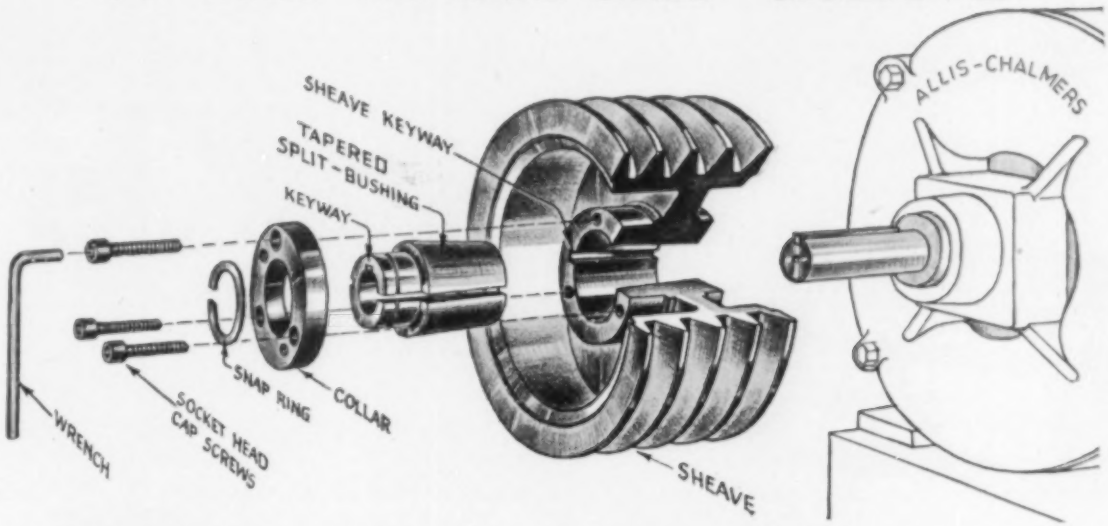
A Paper Company operating a larger unit under continuously heavy load through the same period paid $137,250 for coal. The cost of the equipment was $66,000.

COMBUSTION ENGINEERING

200 MADISON AVENUE • NEW YORK 16, N. Y.

Here's the Inside Story

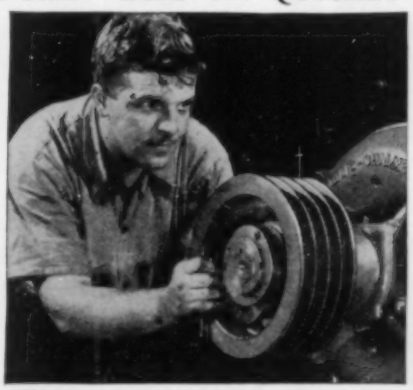
OF THE "MAGIC-GRIP" SHEAVE



Exploded view shows why Allis-Chalmers' new "Magic-Grip" Sheave goes on *as a unit in 2 easy steps.* It's the fastest mounting sheave on the market—at no extra cost.

SEE HOW "MAGIC-GRIP" GOES ON QUICKLY AS A UNIT IN 2 EASY STEPS

1 Place sheave on shaft. Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.



2 Align exactly, using straightedge, (It's easy with this free-sliding sheave.) Then tighten three capscrews; sheave is locked to shaft, *grips like magic!* No set screws to damage the shaft. Write for Bulletin B6310.

RECONVERTING?

GET THIS NEW FREE KIT!

To help you find out how your present equipment will fit into future production, A-C offers a new free "Reconversion Inventory Kit" — Fact Sheets and Check Lists to speed your appraisal of V-belt drives, electric motors, and centrifugal pumps. Applies to all makes. Call your A-C distributor or district office, or write Dept. 41, ALLIS-CHALMERS MFG., Milwaukee 1, Wisconsin.

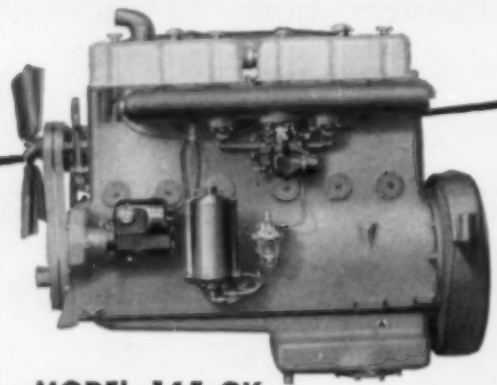
A 1858

Allis-Chalmers Texrope "MAGIC-GRIP" SHEAVES

HEAR THE BOSTON SYMPHONY: *Saturday, American Broadcasting Co.*

20 M.P.H. AS THE SNOW FLIES

...with WAUKESHA-POWERED Roto Wing



MODEL 145-GK

six cylinders, 5¼ in. bore x 6 in. stroke, 779 cu. in. displ.

- ★ Overhead Valves with hard alloy valve seat inserts
- ★ Removable Wet Sleeve Cylinders
- ★ Gear Driven Oil and Water Pumps
- ★ Thermostat Controlled Cooling
- ★ Precision Bearings
- ★ Husky 7-Bearing Crankshaft
- ★ Waukesha Built-In Governor

SEND FOR BULLETIN 1186

● With its rapidly revolving 3-bladed rotor driven by a Waukesha Engine—the Roto Wing plow removes snow from air fields faster than it falls. Drifts 2 to 3 ft. deep vanish at the rate of 20 m.p.h. On highways, snow banks over 3 ft. deep are cut back 5 ft. beyond the road shoulder, at 10 to 20 m.p.h.

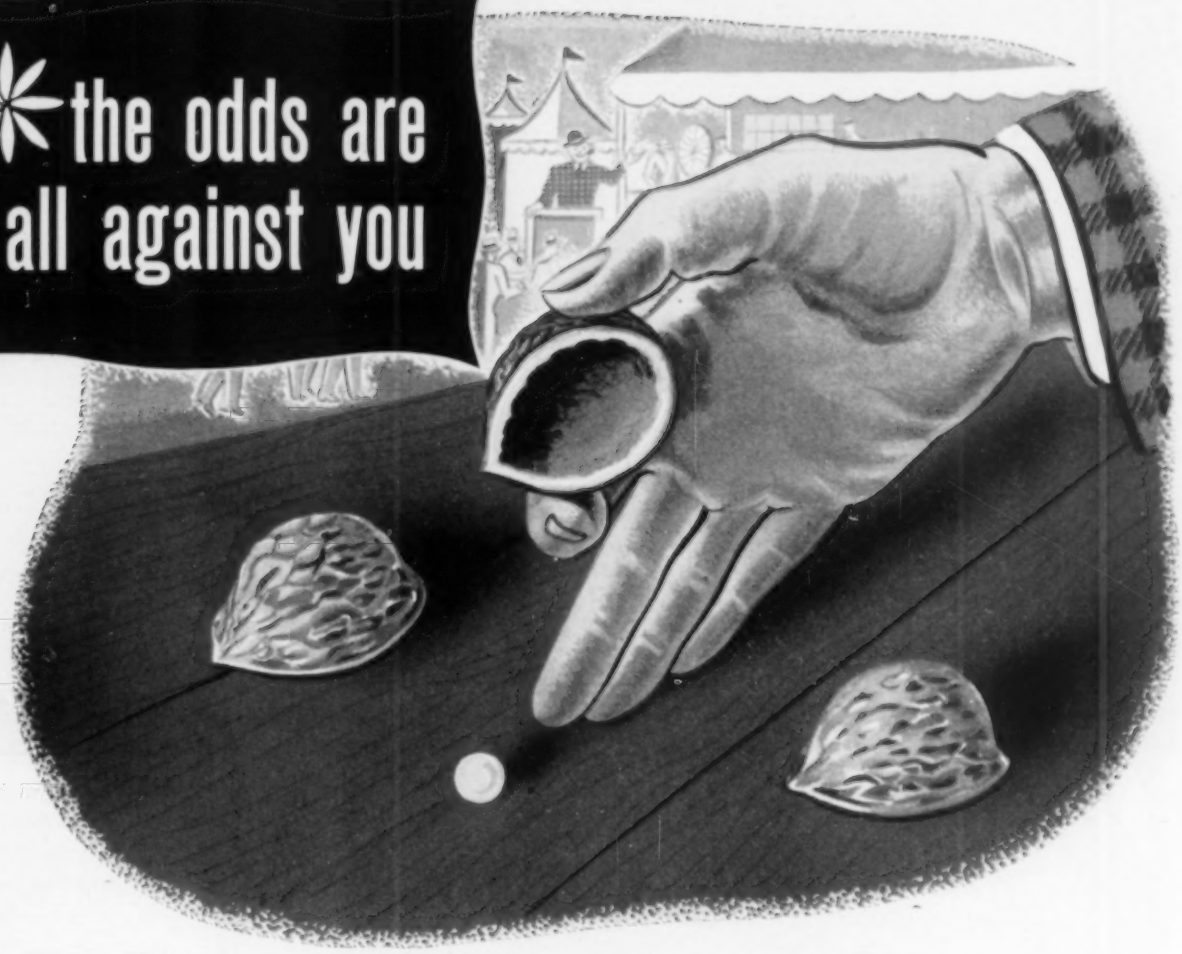
That's throwing snow! It takes sure speed and rugged power. And that super power plant—the Model 145-GK Waukesha Engine—has everything it takes *and more.* That means the utmost in power output, with unfailing dependability.

And, speaking of dependability . . . this snow plow is traveling on a Walters Truck powered with a Model 6-WAK Waukesha, *the* engine for super trucks and buses.

WAUKESHA ENGINES

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS., NEW YORK • TULSA • LOS ANGELES

*the odds are all against you



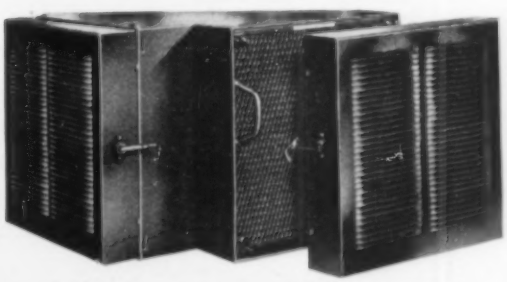
*Gambling is fun when the odds are somewhere near even—but like trying to beat the old shell game—taking a chance on dust getting into your power equipment always ends in disaster.

When you protect engines and compressors with AAF air cleaners you prevent the unnecessary costly, time-consuming breakdowns which always result from excessive wear caused by abrasive dust and grit that gets into their vitals.

Throughout the nation, American Air Filters are prolonging the useful life of valuable power equipment—permitting uninterrupted operation on stepped-up running time and accelerated production schedules. The cost of AAF "preventive maintenance" is insignificant compared to savings in wear, running time and man-hours. Write for free literature.

TYPE "OC-H" FILTER

Composed of complete assemblies of individual viscous impingement type cells and housings which bolt directly to flange on air intake pipe. Installed outside or inside the buildings. Sturdily built for long years of service. Recommended particularly for use in industrial districts involving normal dust concentrations. Write for Bulletin 120 D.



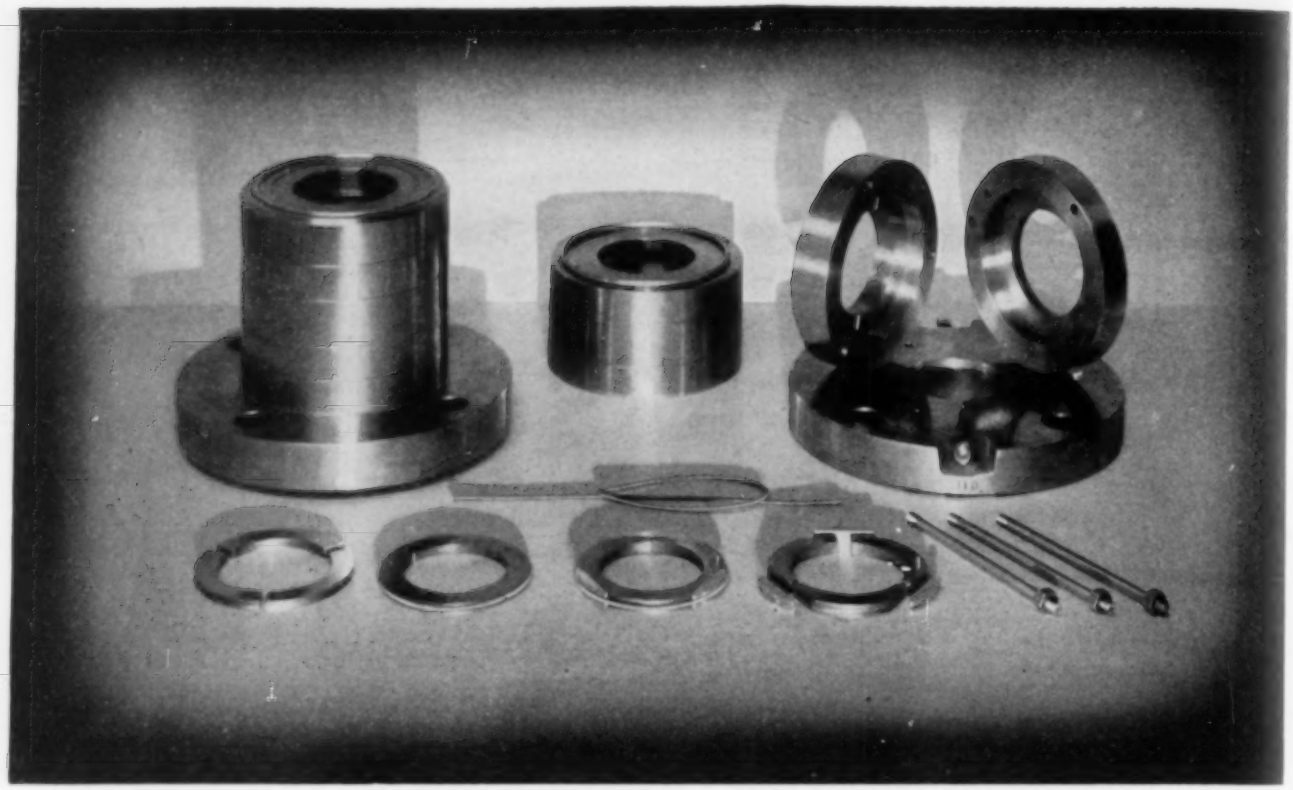
A complete line of Engine and Compressor filters have been developed by AAF engineers thru years of experience with every kind of air cleaning problem. Bulletins descriptive of each type from unit to large automatic, self-cleaning filters for multiple unit service are available without obligation.

AAF

AMERICAN AIR FILTER COMPANY INC.

INCORPORATED

402 Central Avenue, Louisville 8, Ky.—In Canada, Darling Bros., Ltd., Montreal, P. Q.



PRECISION

COMPRESSOR ROD PACKINGS

MORE HORSEPOWER AT LESS COST is the net result when your engine or compressor is equipped with COOK'S Precision Metallic Packings. Here's why:

Precision construction assures positive seal of the pressure. Basic design allows for rod misalignment and vibration, without added friction and wear, provides automatic compensation for wear and guarantees a constant oil film between rings and rods.

Regardless of the make or type of your equipment you can have the improved operation and years of repair-free service COOK'S Precision Packings bring, because there is a proved type and material for all prevailing pressures and temperatures. Shown above is the annular cup type.

Many engine and compressor manufacturers supply COOK'S Packings as original equipment —others furnish them on request. So, when ordering new equipment, specify COOK'S Packings.

For equipment in service, write or call our nearest office.

Sealing Pressures Since 1888

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CRANE Supplies Everything

ONE SOURCE OF SUPPLY
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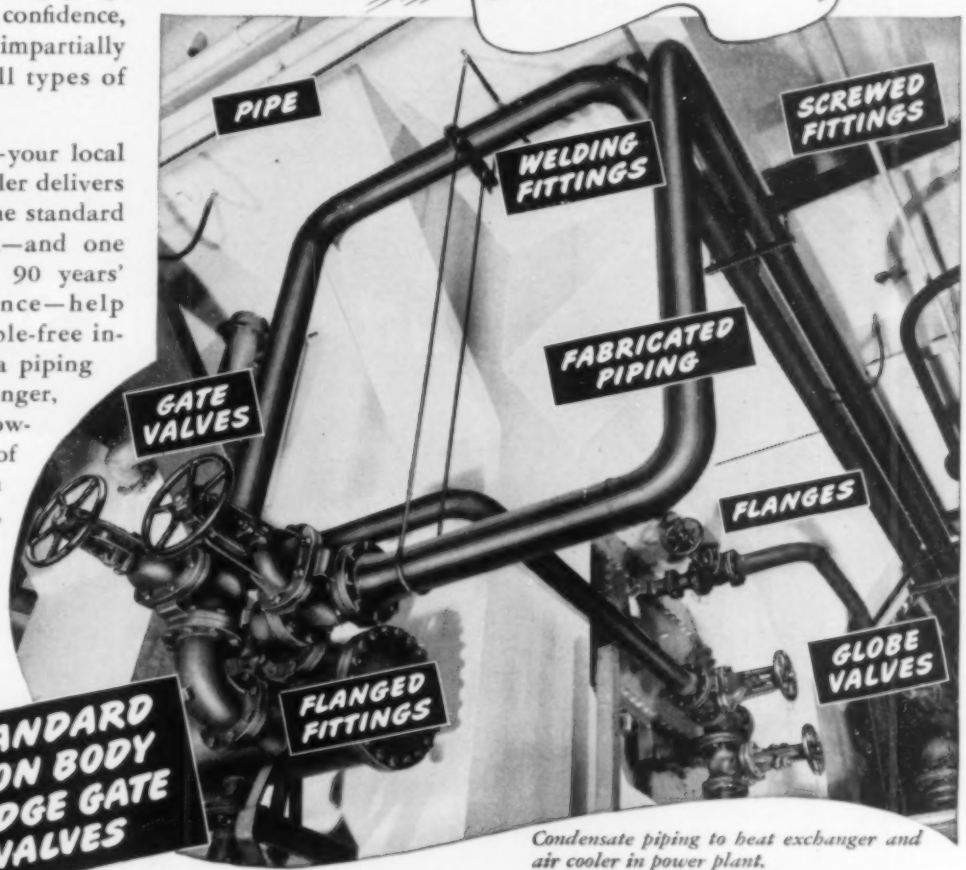
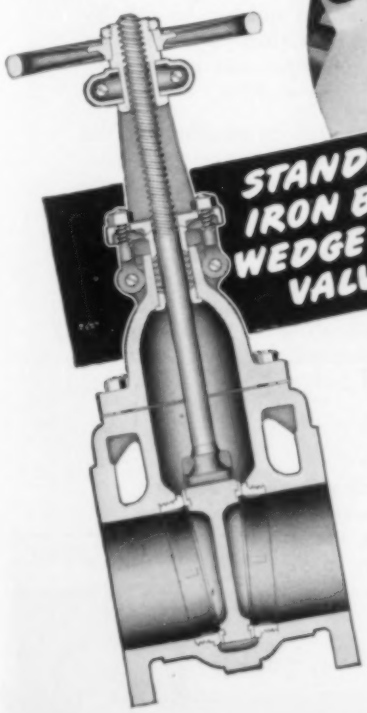
Whether your piping reconversion job is big or small, Crane is your logical partner to help get it done quickly. You select *all* materials from the world's largest line of valves, fittings, pipe, accessories and fabricated piping. You specify with complete confidence, for Crane can point out impartially the relative merits of all types of piping equipment.

Ordering is simplified—your local Crane Branch or Wholesaler delivers everything to the job. One standard of quality in every item—and one responsibility backed by 90 years' manufacturing experience—help assure time-saving, trouble-free installations. The result is a piping system that will operate longer, at highest efficiency and lowest cost. For one example of *complete* Crane lines in brass, iron, and steel valves, see below.



Condensate piping to heat exchanger and air cooler in power plant.



SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** are suited for many services in factories and power plants, at all working pressures up to 125 pounds steam. Brass trimmed valves are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O.S. & Y. and Non-Rising Stem patterns. See page 101 of your Crane Catalog.

WORKING PRESSURES

Size of Valve	Screwed or Flanged End Valves		Hub End Valves
	Saturated Steam	Cold Water, Oil or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-in., Crane 150-Pound Cast Steel Gate Valves are recommended. (For sizes under 2-in., use Crane Clamp Gate Valves.)

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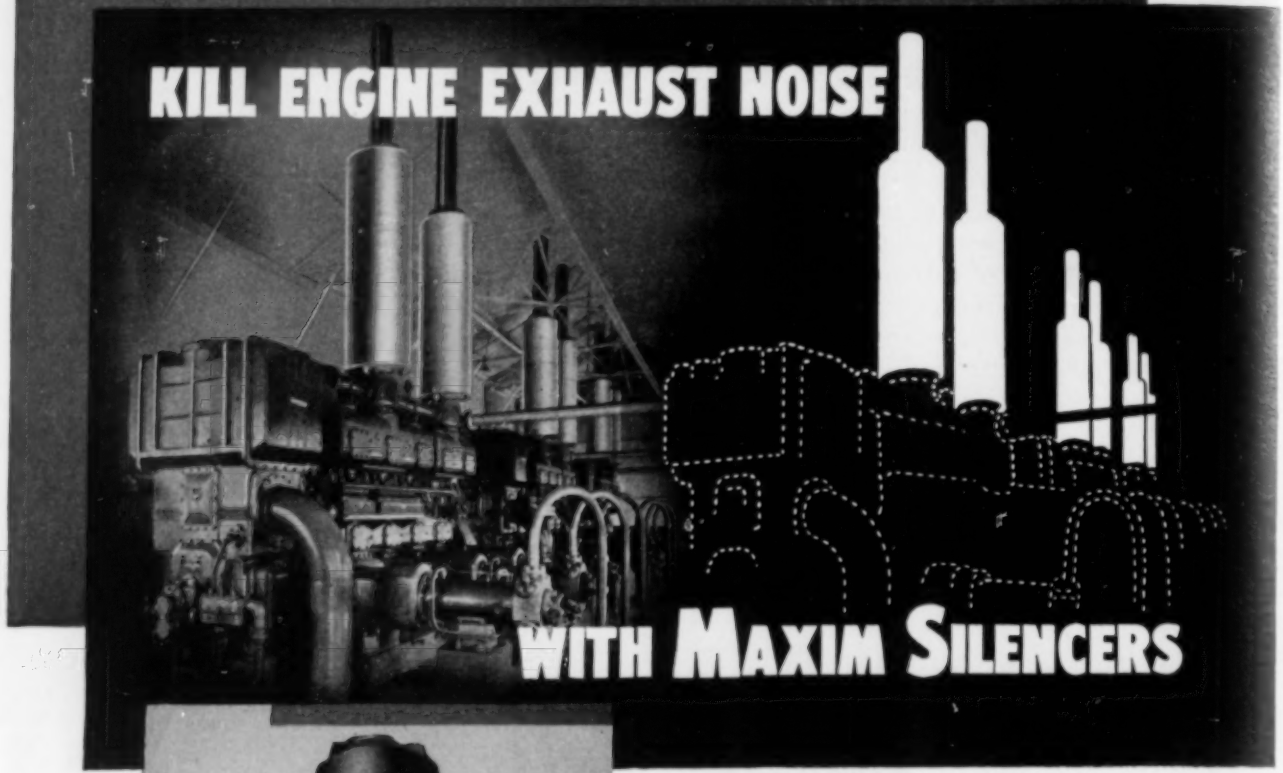
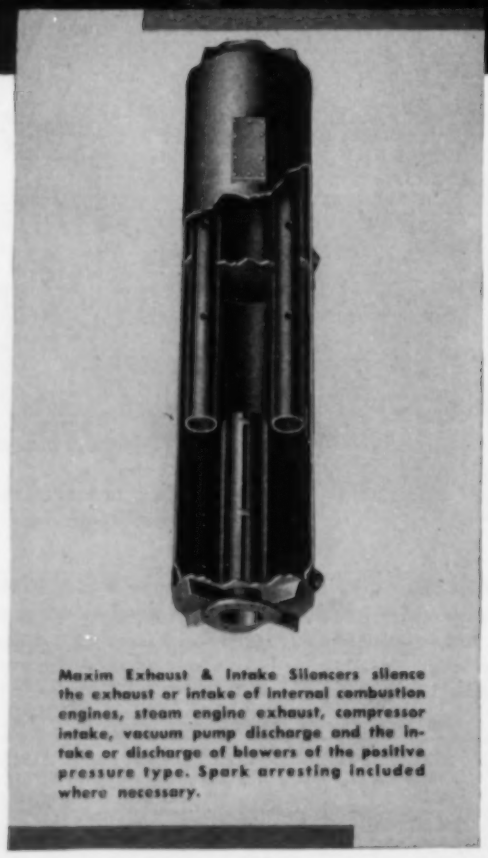




Maxim Exhaust & Intake Silencers silence the exhaust or intake of internal combustion engines, steam engine exhaust, compressor intake, vacuum pump discharge and the intake or discharge of blowers of the positive pressure type. Spark arresting included where necessary.

Adequate silencing of engine exhaust noise is an operating necessity today. The engines shown above could, without proper silencing, make a public disturbance that would quickly be felt by those in charge of plant operation. With Maxim Silencers, however, exhaust noise can be reduced to a point where it is scarcely audible.

Maxim engineers will be glad to recommend the correct silencing equipment to best meet your particular problem. Send your specifications to the address given below.

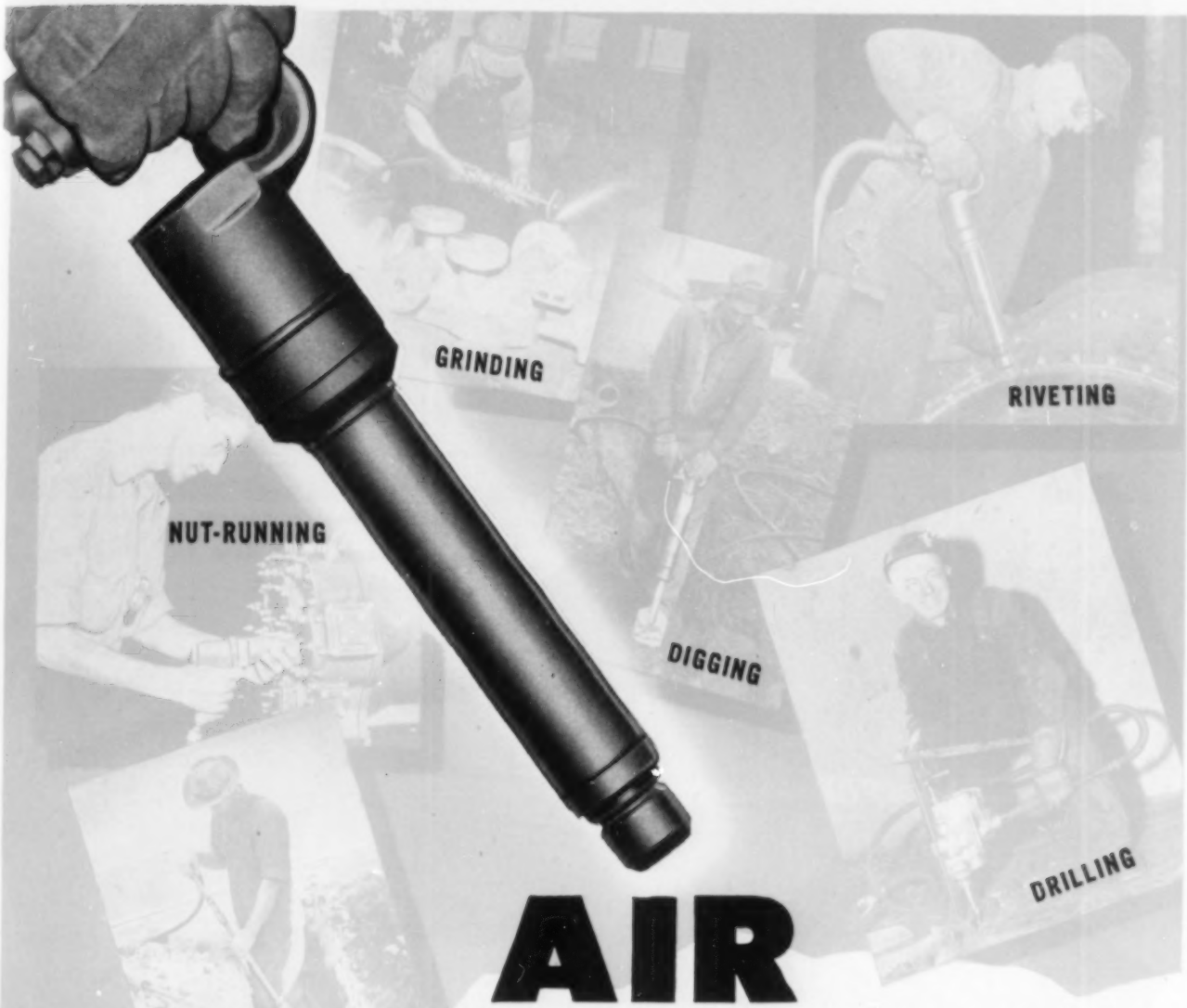
Maxim also makes Heat Recovery Silencers which combine efficient silencing, spark arresting, and the recovery of waste exhaust heat to produce steam or hot water for heating or processing operations. These are described in Heat Recovery Bulletins WH 100, WH 101 and WH 103.

WRITE FOR BULLETINS describing exhaust & intake silencers D 125, D 127, D 101, D 37.

THE MAXIM SILENCER CO. 61 HOMESTEAD AVE., HARTFORD, CONN.

ARMY ★★ E ★★ NAVY ★★

MAXIM



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Down through the ages man has known that air is essential to life. Gradually he began to employ this life-maintaining air for his own practical purposes, such as fanning a fire or sailing his primitive canoe. Today, the applications of air, especially compressed air, are virtually unlimited.

Now, hundreds of processes depend upon air at pressures from a few ounces to thousands of pounds per square inch. Among the more important uses is power for portable, hand-held air tools. So broad are the applications of these popular machines as labor-aiding devices that their uses, too, are unlimited.

There are many reasons for the wide acceptance of I-R AIR tools. They are...light in weight...durable...powerful...easy to handle...safe...and they are backed by seventy-five years of experience in building compressed air equipment.

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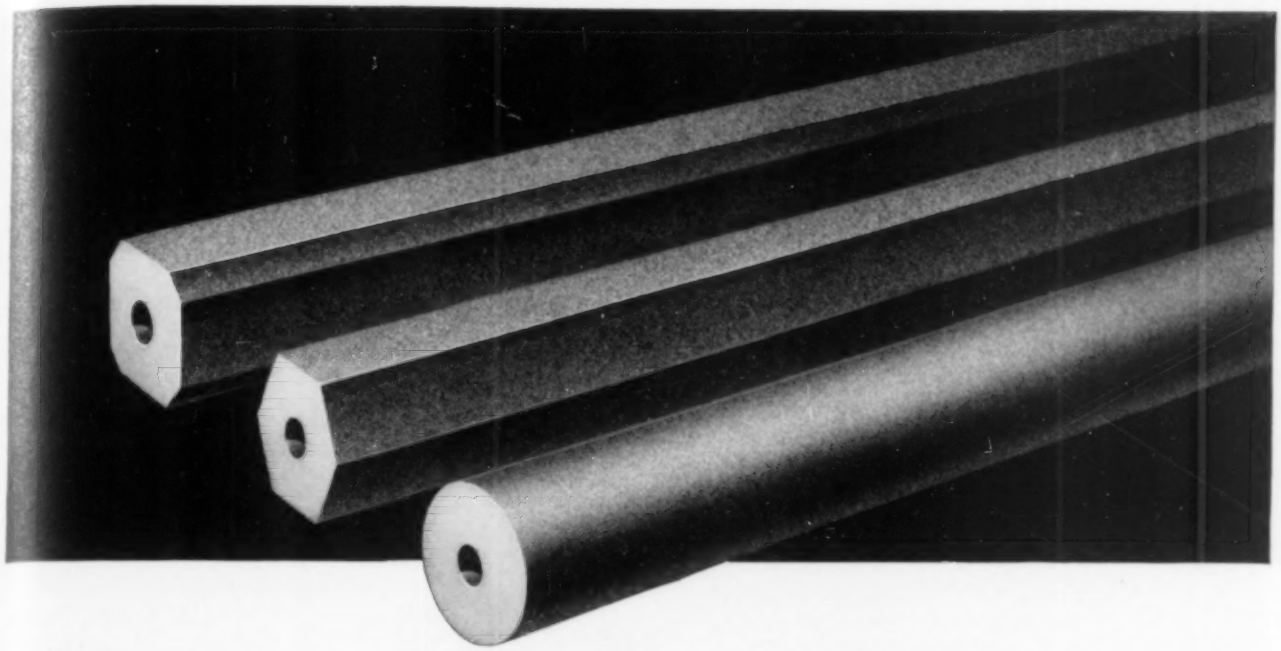

Your rock drills can't do it all

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When you carefully invest your dollars in good rock drills, be equally careful that you get Bethlehem Hollow Drill Steel. After all, the steel's the thing that actually does the cutting. When Bethlehem Hollow is working for you, there is no question of its ability to absorb hard knocks and *keep drilling*, even through the most quarrelsome rock.

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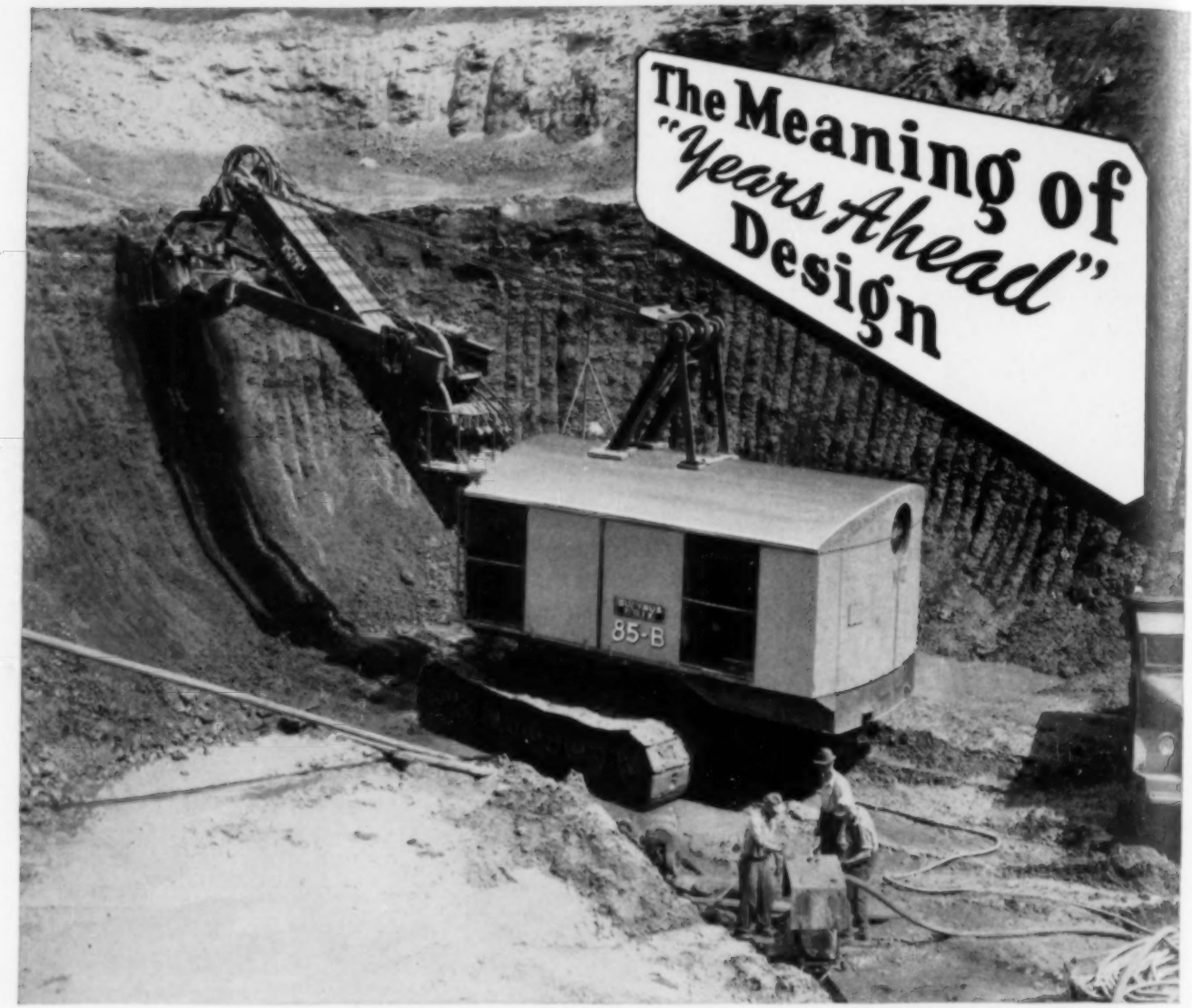
When ordering drill steel, always remember:

BETHLEHEM HOLLOW

makes a good drill better

★ BETHLEHEM STEEL ★



IMPORTANT new designs and improvements are rarely the results of good luck; most of them come the hard way, from intensive research by skilled engineers working with ample facilities and a thorough knowledge of the field. That's especially true of mining shovel design, where so much depends on constant close contact with current field problems, on engineers with the "know how" to develop practical ways to solve those problems, on manufacturing facilities extensive enough to permit really progressive design. To these must be added an ever-present determination to build the finest possible equipment; to consider thoroughly suggestions and recommendations from the men on the job, with the aim of steady improvement.

Bucyrus-Eries are "years ahead" because they are scientifically designed and built to fit the exact needs of the men who will use them, the men to whom "years ahead" design means the most in dollars and cents.

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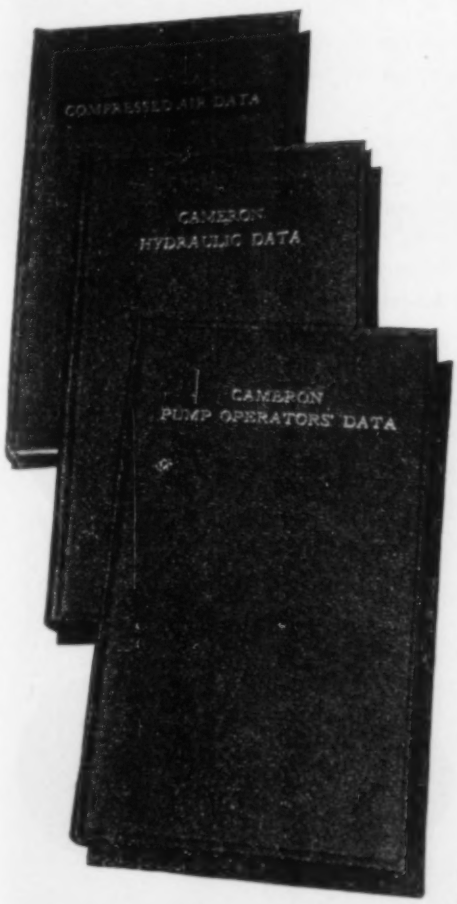

COMPRESSED AIR DATA (Fifth Edition): 408 pages on the theory and practice of compressed-air engineering. 13 chapters devoted to terminolgy and definitions; theoretical compression of air; boosters and vacuum pumps; turbo or centrifugal blowers and compressors; tables and data; intake air; after-cooling, intercooling, reheating; cost of compressing air; pumping with air; gas compression; installation of compressors; belting; application and performance; and measurement of air flow. Many illustration and formulae.

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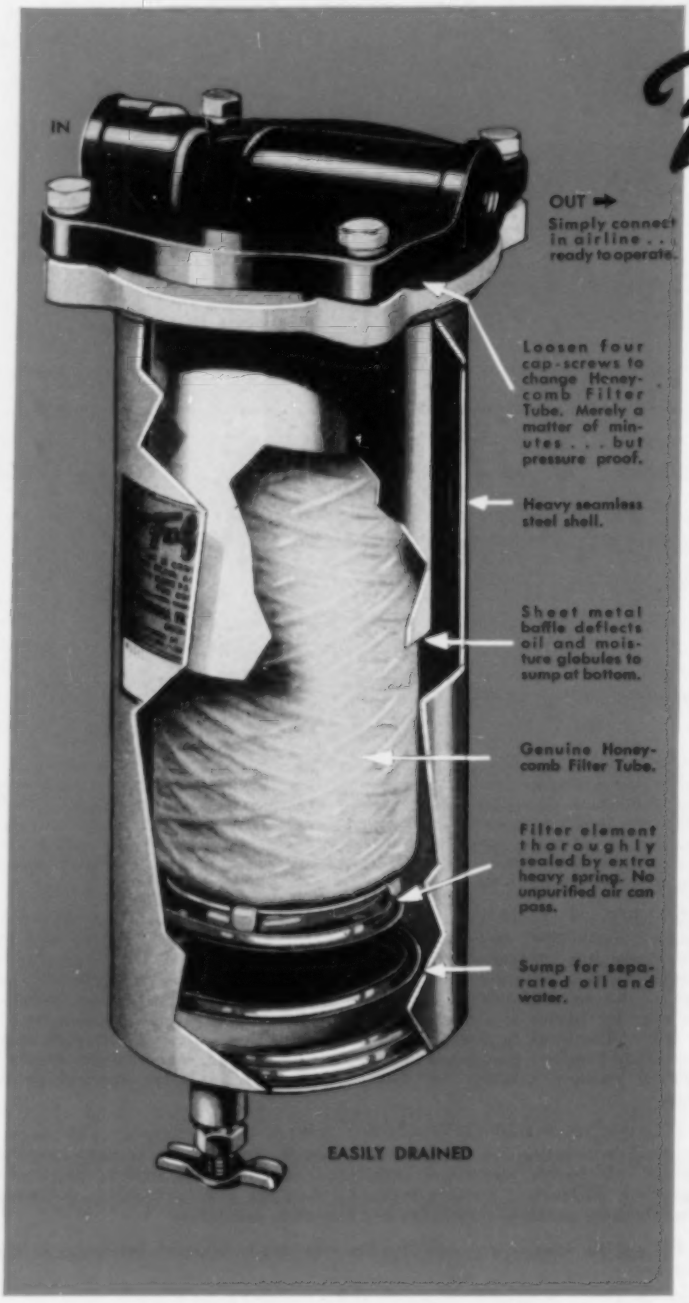
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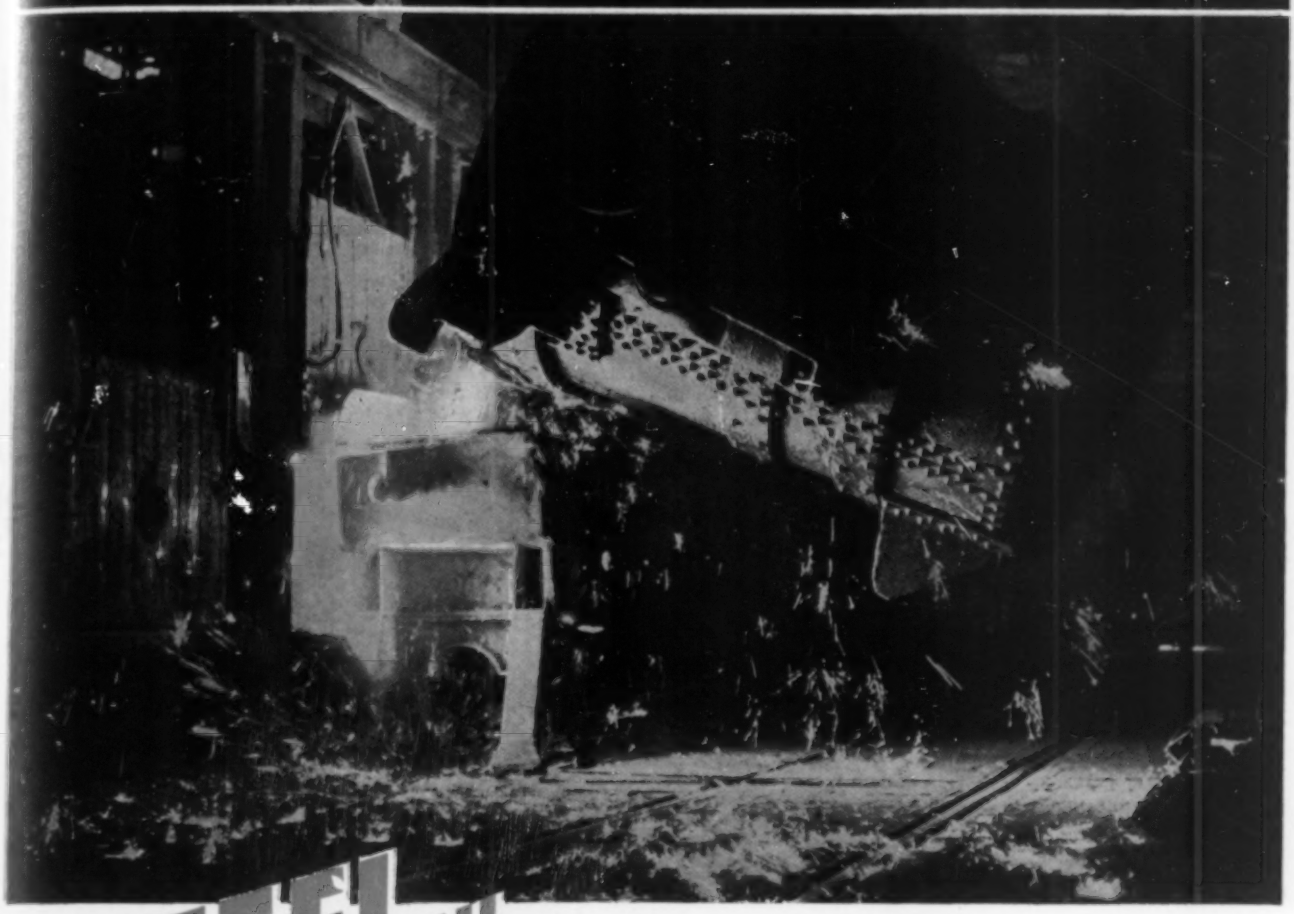

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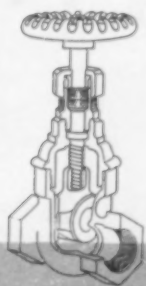
The large quantities of Fairbanks Valves used in the steel industry afford a striking example of what we mean when we say "American Industry flows through Fairbanks Valves." This wide line of bronze and iron valves is backed by more than fifty years of frequent advances in manufacturing . . . consistent improvements in materials.

Fairbanks Catalog Number 42 gives specifications, prices. If it's not in your files now, we suggest you write today. When we send it, we'll advise you of nearest distributor.



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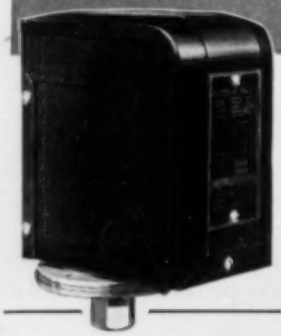
for AIR COMPRESSORS and WATER PUMPS



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225 lbs. pressure limit
10 to 45 lbs. differential

● A standard controller for motor-driven air compressors and water pumps. Heavy contacts, with silver permanently bonded to the heavy bronze backing. Generous electrical ratings. Four ⅞ inch knockouts for ½ inch conduit are provided for convenient wiring.

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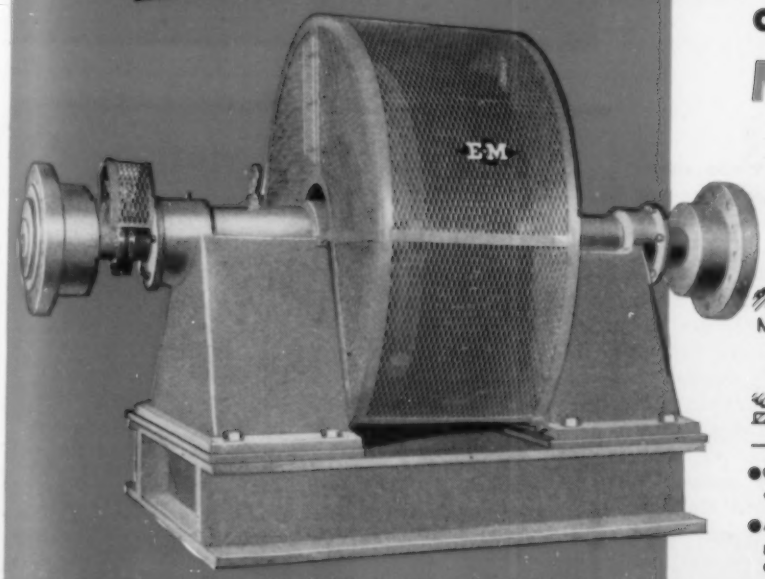
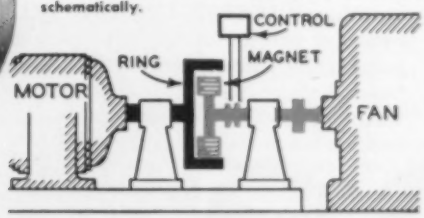


SEND FOR NEW ILLUSTRATED BOOKLET NO. 183 DESCRIBING THE MAGNETIC DRIVE

QUICK FACTS ABOUT THE Magnetic Drive

- The E-M Magnetic Drive is a simple, compact, electro-magnetic torque-transmitting device.
- It consists essentially of a ring, driven by the motor, and a magnet coupled to the fan, as illustrated schematically.



- Closely adjustable-speed from maximum down to 10% of motor speed .. controlled electronically.
- Advantages: Precise fan speed control — Maximum fan power economy — Minimum fan wear from erosion — Quick speed response — Simple rugged construction.

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Adjustable-Speed MAGNETIC DRIVES

Pay for themselves through better boiler control, longer fan life, and power savings!

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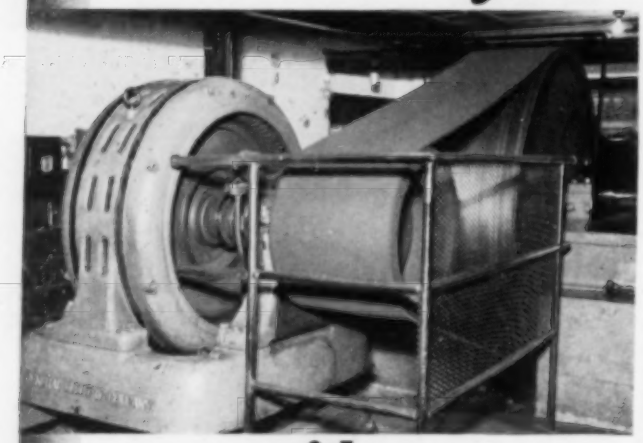

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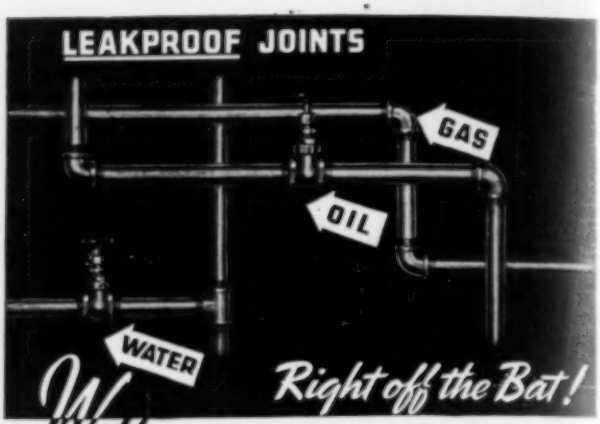

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- *Ready for use,* in 1, 5, 7-lb. cans.

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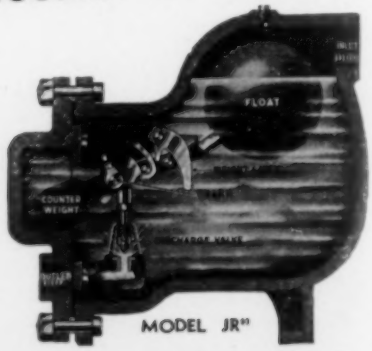
Approved "prescription" for problem air tanks

Write for Bull. 341



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Many plant records prove you can prescribe them to clear air tanks and promote efficiency. Exclusive weight-operated design, open and close instantaneously, giving full, positive, trouble-free drainage of water and oil. Pressures to 200 lbs.

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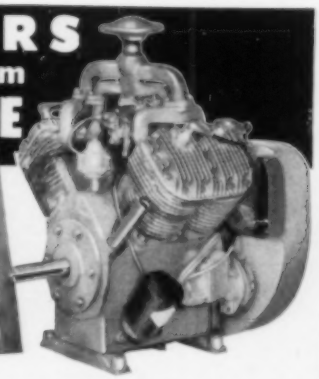
on all WISCONSIN 4-Cylinder V-Type Air-Cooled ENGINES



The cylinders on all V-type Wisconsin Air-Cooled Engines are cast in pairs, separate from the crankcase, for quick, economical servicing when required. In case a cylinder is accidentally scored beyond the possibility of reboring, it is only necessary to replace a relatively inexpensive pair of cylinders instead of an entire engine block. The picture shows the Model VE-4 Wisconsin Engine, with protective shrouding removed, illustrating method of attaching cylinders.

Most H.P. per pound

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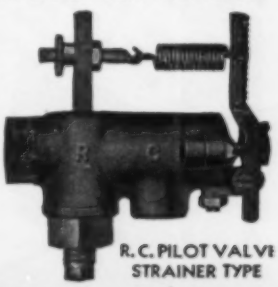
R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



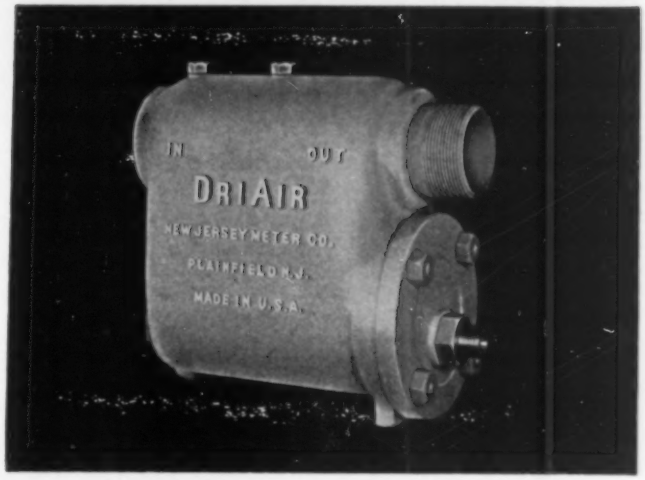
R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.

1207 FRENCH STREET - ERIE, PA.

PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

● The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

Garlock 7021 Sheet Packing won't have to stand up against the impact of a rushing ram, of course, but if it did, we think it could take it. For this compressed asbestos sheet is plenty tough. GARLOCK 7021 gives exceptional service on pipe lines and other equipment handling gasoline, oil, gas or steam at high temperatures and extreme pressures. Avoid gasket failures and expensive shut-downs by standardizing on GARLOCK 7021.

GARLOCK 7021 Compressed Asbestos Sheet Packing is available in sizes 40" x 40" and larger. Thicknesses 1/64" to ¼".

GARLOCK 7022 Gaskets — cut from this sheet — are available in all sizes and shapes.

GARLOCK 7021

COMPRESSED ASBESTOS SHEET PACKING

THE GARLOCK PACKING CO.
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

COMPRESSED AIR LINE PURIFICATION YOUR PROBLEM?

Here's the Answer...

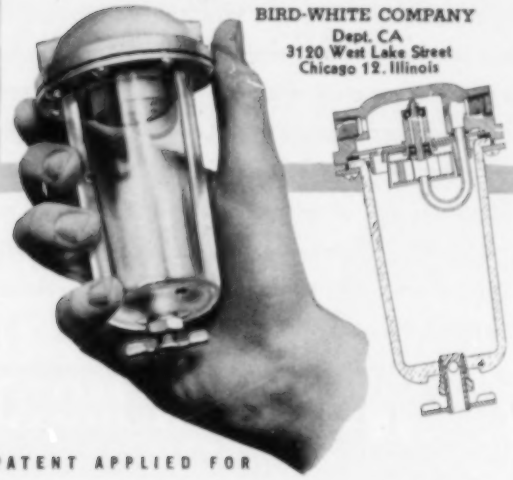
The new Bird-White Pur-O-fier A-1 assures you of positive elimination by turbo-rotor centrifugal action of all free moisture, oil and foreign matter in small compressed air or gas systems. It operates with from 1 to 5 cubic feet of air (1 to 75 p.s.i.) and for intermittent operation is extremely sensitive.

Among many other uses this new unit is ideal for protecting air pressure operated machinery and instruments from corrosion and gumming.

For complete specifications and applications write today for Bulletin No. 11.

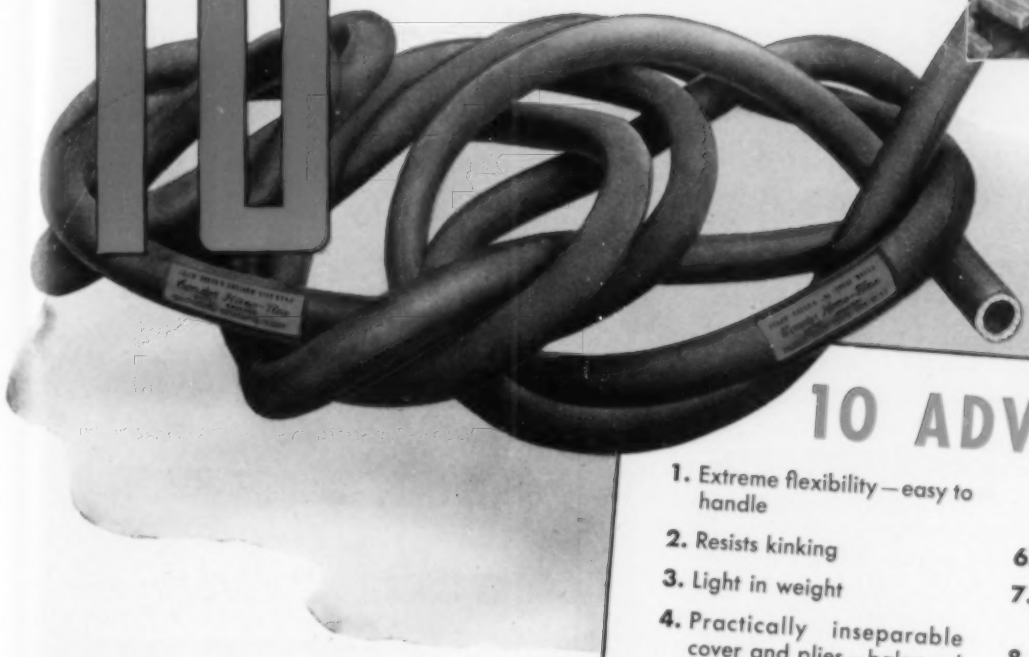
Bird-White Pur-O-fiers are also available in other models for purification of large volumes of compressed air or gas. Ask for Bulletin No. 10.

BIRD-WHITE COMPANY
Dept. CA
3120 West Lake Street
Chicago 12, Illinois



PATENT APPLIED FOR

10



10 ADVANTAGES

1. Extreme flexibility—easy to handle
2. Resists kinking
3. Light in weight
4. Practically inseparable cover and plies—balanced homogeneous construction
5. Withstands high pressures and surges with wide margin of safety
6. Uniform inside diameter
7. Less elongation and expansion
8. Less fatigue to operator
9. More production
10. Lower ultimate cost

Condor HOMO-FLEX HOSE

contributes to greater production and longer hose life

Every one of these 10 advantages contribute to the multiple economies of long service life; resistance to high working pressures and surges; easy handling with less operator fatigue; toughness to withstand wear, abrasion and kinking.

Still another **MANHATTAN** advantage—Turnate Vulcanization—imparts added strength to Homo-Flex Hose. This process gives uniform inside and outside diameters, uniform texture and resiliency to the **MANHATTAN** Strength Members and the FLEXLASTICS tube and cover.

Condor Homo-Flex Hose is or will be available in types for the following services: Air, Water, Steam Pressing Iron, Orchard Spray, High Pressure Mine Spray, High Pressure Oil Spray. Write for Bulletin No. 6879.

The term FLEXLASTICS is an exclusive MANHATTAN trade mark. Only MANHATTAN can make FLEXLASTICS.

THE MANHATTAN RUBBER MFG. DIVISION

OF RAYBESTOS-MANHATTAN, INC.

Executive Offices and Factories **PASSAIC, NEW JERSEY**

THE MOST BRILLIANT NAME IN LEAD PENCILS

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Like the WORLD FAMOUS KOH-I-NOOR DIAMOND, KOH-I-NOOR PRODUCTS have long been famous for their outstanding qualities. Whatever is required in pencil performance will be found in our exceptional quality lines.

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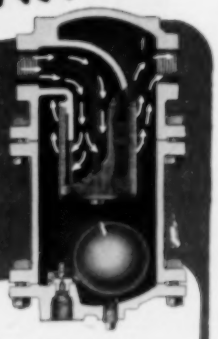
BLOOMSBURY, N. J.

SELF DRAINING

Today's newest idea in SEPARATOR DESIGN . . .



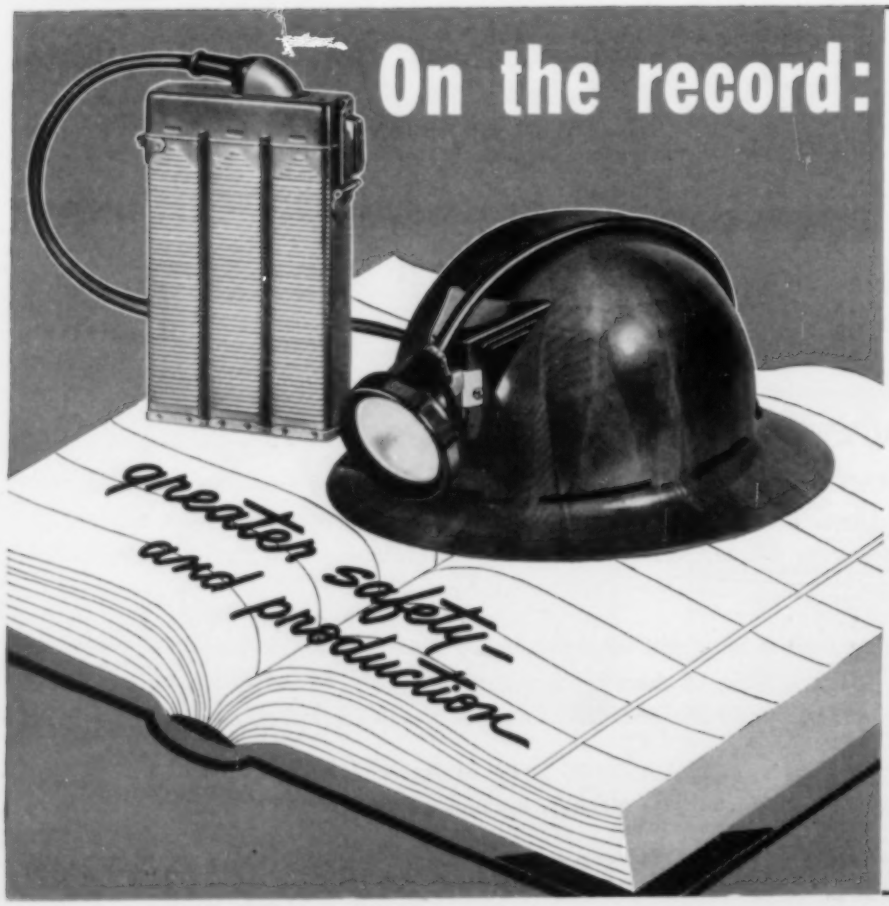
● With this new Johnson Type "SA" Separator there's no need for external traps—no more bother and uncertainty of manual draining. It has a complete trap mechanism built right in—drains itself automatically whenever necessary.

Like all Johnson Separators it removes more than 99% of all moisture and dirt from compressed air or steam. It can be teamed up with the Johnson Aftercooler where moisture has been vaporized by heat of compression, or with the Johnson Oil Absorber where every trace of oil must be removed.

Johnson Separation Devices come in sizes, styles for all needs. Write for new bulletin.

THE Johnson Corporation

830 WOOD STREET, THREE RIVERS, MICHIGAN



THE safety of better light provided by the Edison Electric Cap Lamp and the greater head protection of the M.S.A. Skullgard are serving men in mines of every type and size . . . the higher production at lower costs aided by this modern equipment are proved in the books of mining companies throughout the world. May we arrange a demonstration in your own operations?

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ELECTRIC CAP LAMPS

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MINE SAFETY APPLIANCES CO.

BRADDOCK, THOMAS AND MEADE STS.
PITTSBURGH, PENNA.

District Representatives in Principal Cities

It's as simple as it looks

AIR TAMPING...

... first of all, air tamping takes the lightest tie tamper known — the Ingersoll-Rand MT-3. The operator has only to guide it as the machine does the work. And the work is always uniform as the tamper strikes steady, even blows all day long. Fatigue does not affect the machine and its light weight and easy-holding qualities reduce operator fatigue to an absolute minimum.

To speed up your tie tamping operations, we suggest you investigate the MT-3 tamper and also I-R air compressors for the air power — both off- and on-track units are available.

AIR TOOLS
COMPRESSORS
ROCK DRILLS
TURBO BLOWERS
CONDENSERS
CENTRIFUGAL PUMPS
OIL & GAS ENGINES

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how to keep OLD motors YOUNG

Why more Westinghouse **SK Motors** are used in coal mines today than all other makes combined

One-piece rolled steel frame—with drop-forged steel feet welded to frame, gives great mechanical strength.

Separate coil units—shunt, series and commutating coils are wound and insulated as separate units, simplifying replacement.

Sealed-sleeve bearings—with exclusive Westinghouse vestibule seal, keep oil inside, keep dust and dirt outside.

Form-wound armature coils—on larger sizes are insulated with specially selected mica on slot portion and dipped and baked in long life varnish. Smaller sizes have mush-wound coils.

Readily accessible brushes—easily adjusted or removed. Any one brushholder can be removed without disturbing others.

Field coils—wound on a one-piece Micarta shell with end washers punched to exact size, protecting the coil against dirt and moisture.

Commutators—made of punched hard drawn copper for uniformity, better commutation and longer brush life.

Whether it's 10 years old... or 20... or even if it's one of the first SK Motors ever installed back in 1911, the same replacement armature will fit. This is true also of armature coils, field coils and sealed-sleeve bearings—to keep older models always modern in performance.

This is true of SK Motors because the basic construction has always been kept the same, and because all improved parts have been designed to fit former models of the same rating and frame size. To the user, this means greatly simplified maintenance and the smallest of parts stocks.

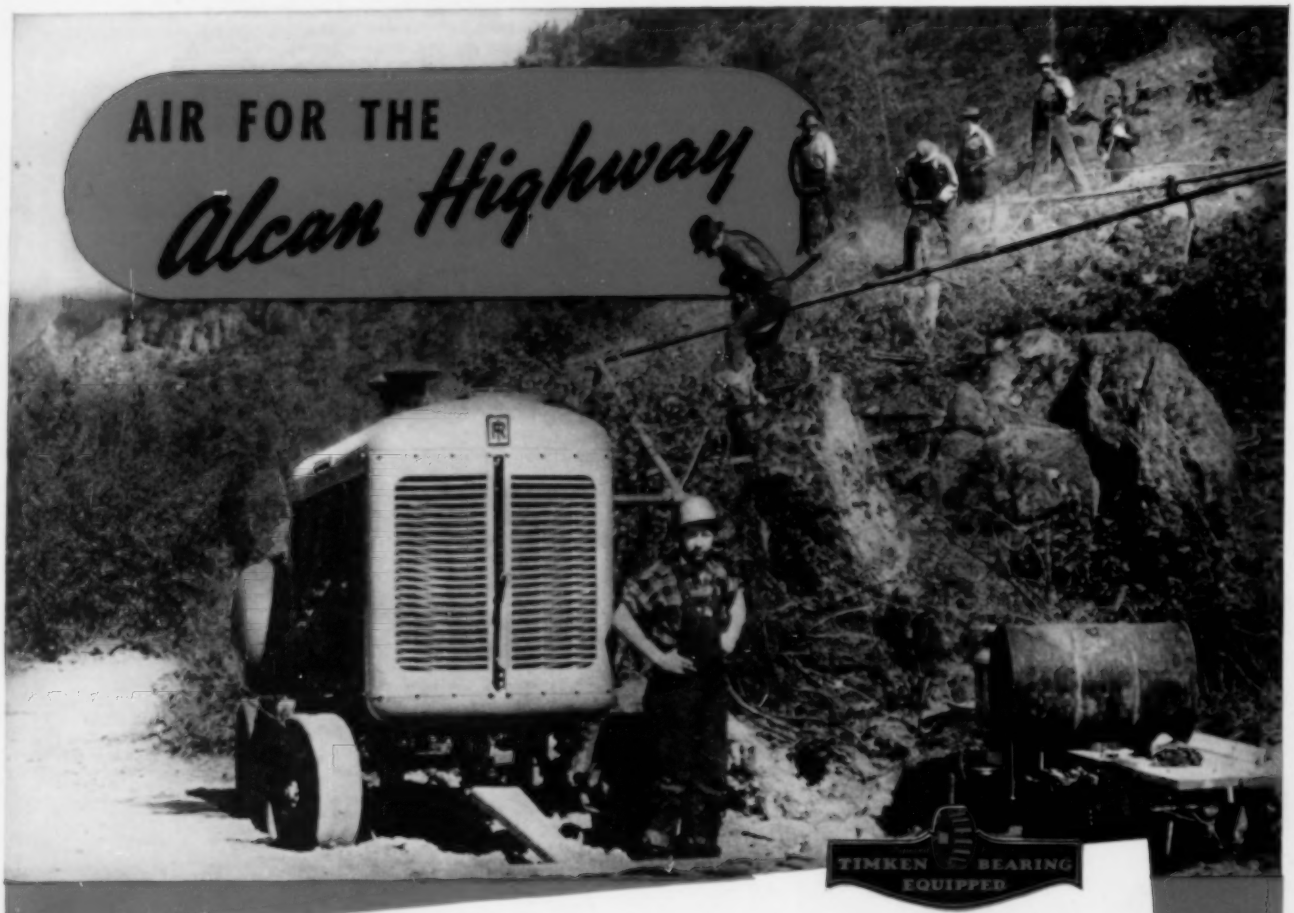
Furthermore, SK Motors have been unsurpassed in dependability and economical service throughout the 34 years that they have been a coal industry standard. For further information, see your Westinghouse representative, or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21361

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

SK MINING MOTORS

Because a Jackhamer strikes 2,000 hard blows a minute...
SHELL CLAVA OIL KEEPS AIR TOOLS "ON THE GO"
1. Its great film strength assures protection for all moving parts under the most severe operating conditions.
2. Flows freely through the lubricating system at all temperature ranges encountered.
3. Has high wetting ability . . . protects internal drill parts against rust.
4. Does not form "gum," keeps valve action free. Seals pistons effectively.
5. Adheres to metal surfaces, making it possible for a small quantity of oil to do a complete lubrication job over long operating periods.
6. Carbon formation is reduced to a minimum.
NOTE: To assure adequate lubrication at all times the use of an air-line lubricator is recommended.
A "LAZY" OIL WON'T DO!
IN order to give trouble-free performance, an air-drill lubricant must do more than just lubricate. It must have all of the characteristics listed in the box at left. Any oil that does less is a "lazy" oil . . . causes costly production delays.
Shell Clava Oil has all of the characteristics necessary for reliable air tool performance. That's why operators have found that by using hard-working Shell Clava Oil, air tools stay "on the job" for longer periods of time, prevent excess wear of parts.
Call in the Shell man now. Let him show you how your air tools will serve you with utmost dependability when lubricated with Shell Clava Oil.
SHELL COMPRESSED AIR LUBRICANTS
COMPRESSA OIL
FOR AIR COMPRESSORS
CLAVA OIL
FOR AIR TOOLS



Rock removal was a major operation in the construction of the Alcan Highway and compressors by the score were used to furnish the air for rock drilling.

A typical scene in this phase of the work is shown above. The compressor is an Ingersoll-Rand Type K-500 Mobil-Air, one of the largest portable compressors made. As in other models of Ingersoll-Rand compressors, Timken Tapered Roller Bearings are used at the main crankshaft bearing positions assuring smooth operation; prevention of crankshaft wear; constant crankshaft alignment; and full protection against radial, thrust and combined loads.

When buying an anti-frictionized compressor of any type make sure it is equipped with Timken Bearings and get anti-friction performance at its best.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS